

EXPLOSION BONDED CLAD METALS

NC 501 General Specification
Revision N°5 – December 3rd , 1999

Date of revision	Number of revision	Written by	Checked by	Approved by	Remarks
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The following details are required by the manufacturer to ensure that orders are produced in compliance with this specification.

- Construction code and / or national regulation - if any.
- Reference to specification NC 501.
- Base and cladding metal specifications with the applicable standard edition.
- Dimensions and condition of plates before cladding when supplied by the purchaser (Ref. to Nobelclad's specification attached to the offers).
- Whether central ignition is permitted (acc. to NC 501 § 4.1).
- Net sound bond sizes dimensions of the ordered clad plates and tolerances (acc. to NC 501 § 4.3). If possible, a drawing of finished product.
- Condition of supply (acc. to NC 501 § 4.2, 4.4 & 4.5).
- Any additional marking required in addition to that specified by NC 501 § 4.5
- Ultra-sonic acceptance level for bonding with the dimensions of the sound bond area (acc. to NC 501 § 5.1).
- Mechanical tests (acc. to NC 501 § 5.2).
- Type of inspection for the constituent metals (acc. to NC 501 § 6.1).
- Type of inspection of the bonding and tests required (acc. to NC 501 § 6.2).
- Required packing (acc. to NC 501 § 7).

DIMENSIONS IN INCHES ARE INDICATED FOR INFORMATION ONLY.

1 - SCOPE

This document sets forth the main characteristics of explosion bonded clad plates as well as the applicable technical specification and delivery conditions. This specification applies to plates used for pressure vessels, heat exchangers and condenser plates produced by NOBELCLAD and its subsidiary NITRO METALL (hereinafter referred to as NOBELCLAD).

2 - COMPOSITION OF CLAD PLATES

2.1. The plates under this specification shall contain two or more layers of metals of different quality and thickness'. They shall be bonded to each other by means of the detonation of an explosive.

On occasion, they may contain more than one layer of one metal.

The bond between the layers is achieved at ambient temperature without significant alteration in the thickness and chemical analysis of the metals.

Metals used to manufacture clad plates shall comply with applicable standards and any particular requirements specified in the purchaser's order. They can be supplied either by the manufacturer or by the purchaser. When the manufacturer purchases metals, the purchaser shall indicate on his order any additional tests and controls to be carried out

before cladding. Without this information, metals shall be ordered in accordance with the minimum of the applicable standard (without any other restriction).

2.2. The manufacturer can weld sheets together according to the following procedures when the width or length required for the cladding sheet is greater than the dimensions available (from stock or production):

- ASME IX for PQR, WPS and WPQ
- ASME II C for welding filler materials.

Unless otherwise specified, standard reference code for welding procedures and qualifications shall refer to ASME Boiler and Pressure Vessel Code, latest applicable edition.

A 100 % radiographic examination together with a 100 % liquid penetrant test shall be carried out on the welding seam according to ASME V.

Acceptance criteria shall be those of ASME VIII Division 1
(They can comply with other codes such as AD Merkblätter or CODAP if required by the purchaser).

3 – MATERIAL SUPPLIED BY THE PURCHASER

The purchaser can supply the material to Nobelclad. In this case metals shall meet the clad plate manufacturer's own requirements. These requirements shall be communicated to the purchaser before the contract signature.

3.1. BASE AND/OR CLADDING METALS

Base and/or cladding metals shall be supplied with relevant mill test reports and shall fully comply with Nobelclad's specifications and indicated dimensions. Failing to this respect will be cause of rejection by Nobelclad.

3.2. WELDING OF CLADDING MATERIAL

The supplier or his subcontractor can weld cladding material before cladding. In this case, the welding seam should be controlled as per § 2.2.

Furthermore, the number of welding seams, as well as their location, should be agreed upon with Nobelclad.

The welded sheets shall meet Nobelclad's requirement as indicated in § 3.1.

4 - CONDITIONS OF SUPPLY

4.1. IGNITION POINT

The ignition point can be located either outside or inside the sound bond area, depending upon the size of the plates, the presence of welding seams and the final application. Its location shall be agreed between manufacturer and purchaser.

4.1.1. OUTSIDE SOUND BOND AREA.

The ignition point does not present any defect in the sound bond area.

Note: The oversize dimensions of the metals are more important in this case.

4.1.2. INSIDE SOUND BOND AREA

Located in the sound bond area, the ignition point generates a defect (usually within the ultra sonic acceptance levels). The size of this may vary with cladding thickness.

Cladding thickness mm (")	Guaranteed maxi. defect mm (")	Max. depth print mm (")
< 6 (0.2")	33 (1.3")	1.5 (0.06")
< 10 (0.4")	60 (2.4")	2 (0.08")
< 15 (0.6")	80 (3.2")	2.5 (0.1")
< 20 (0.8")	140 (5.5")	3 (0.1")

4.2. HEAT TREATMENT

Unless otherwise specified (subsections 4.2.1. and 4.2.2.), explosion bonded clad plates under this specification shall be supplied without heat treatment after cladding. Titanium, Muntz metal, 400 series stainless steels and zirconium on low carbon steel or stainless steel shall undergo a stress-relieving heat treatment.

4.2.1. TEMPERATURES AND CYCLES

Unless it is otherwise specified (subsection 4.2.3.), explosion bonded clad will be heat-treated according to following cycles.

Clad plates	Treatment θ	Holding time	Heating rate	Cooling rate
AISI 300 Stainless steel on Carbon steel	605°C \pm 15°C	1 H / 25 mm (1") Mini 1 H / Maxi 2 H	90°C / Hr maxi between 300°C and treatment θ	90°C/Hr maxi between treatment θ and 300°C
AISI 400 Stainless steel on Carbon steel	675°C \pm 15°C	1 H / 25 mm (1") Mini 1 H / Maxi 2 H		
Zirconium on Carbon Steel*	540°C \pm 15°C	2 H / 25 mm (1") Mini 2 H / Maxi 4 H		
Titanium on Carbon steel*	540°C \pm 15°C **	2 H / 25 mm (1") Mini 2 H / Maxi 4 H		
	605°C \pm 15°C **	1 H / 25 mm (1") Mini 1 H / Maxi 2 H		
Titanium on AISI 300 Stainless steel*	540°C \pm 15°C	1 H / 25 mm (1") Mini 1 H / Maxi 2 H		
Muntz metal on Carbon steel	605°C \pm 15°C	1 H / 25 mm (1") Mini 1 H / Maxi 2 H		
UNS 2205 on Carbon steel	580°C \pm 15°C	2 H / 25 mm (1") Mini 2 H / Maxi 4 H	Same	Air

* Slightly oxidising atmosphere

** at manufacturer's choice

4.2.2. Where mutually agreed, heat treatment shall not be performed on products to be hot formed, provided flattening operations before forming are not carried out. Heat treatment shall be performed on test specimens, corresponding to the heat treatment forming cycle to be specified by the purchaser.

Note: The heat treatment for the forming of heads, or shells shall be specified by the fabricator of heads, or shells, and is the responsibility of the purchaser, to ensure that these are not deleterious to the metals.

4.2.3. PARTICULAR TREATMENT

* Particular treatments, including that for test coupon only, can be carried out upon manufacturer's agreement. Purchaser has to submit complete heat treatment cycle.

* For multi-layer clad material, any heat treatment can be decided by the manufacturer.

4.3. DIMENSIONAL TOLERANCES

Explosion process induces creep. Therefore slight loss on thickness and an increase of dimensions may occur, particularly at the edges.

Clad plates supplied shall allow the insertion of a rectangle (or a disc) of the size specified in the order.

4.3.1. LENGTH AND WIDTH OR DIAMETER

4.3.1.1 NO CUTTING

Unless otherwise specified, the explosion-clad plates will be supplied in the rough, without any further cutting or machining operation.

The plates will have at least, 80 mm over dimensions on width and length, or on diameter (The extra dimensions will be indicated in offers and confirmed in orders acknowledgements).

4.3.1.2 OXYGEN CUTTING

Thickness' - mm (")	Cutting tolerances for square plates and discs - mm (")
Th < 50 (2")	+ 0 / + 20 (0.8")
50 < Th < 100 (4")	+ 0 / + 30 (1")
100 ≤ Th < 150 (6")	+ 0 / + 40 (1.6")

Note: a thermally affected area of 10-mm (0.4") from the cut edge should be assumed.

4.3.1.3 PLASMA CUTTING

Thickness' - mm (")	Cutting tolerances for square plates and discs - mm (")
Th < 30 (1.18")	+ 0 / + 15 (0.6")

Note: a thermally affected area of 5-mm (0.2") from the cut edge should be assumed.

4.3.1.4 ABRASIVE DISC CUTTING

Thickness-mm(")	Length-mm(")	
	L ≤ 2500 (98.4")	L > 2500 (98.4")
Th. < 50 (2")	+ 0 / + 5 (0.2")	+ 0 / + 10 (0.4")
50 ≤ Th. < 80 (3")	+ 0 / + 8 (0.3")	+ 0 / + 10 (0.4")
80 ≤ Th. < 100 (4")	+ 0 / + 15 (0.6")	+ 0 / + 20 (0.8")
Th. > 100 (4")	To be agreed	To be agreed

4.3.1.5 LATHE MACHINING

Weight (kg)	Diameter-mm (")	
	D ≤ 3650 (137.8")	D > 3650 (137.8")
W < 5000 kg	+ 0 / + 2 (0.08")	To be agreed

4.3.2. THICKNESS

Unless otherwise specified, the explosion clad plates, discs shall be supplied according to subsections 4.3.2.1, and 4.3.2.2. (For metals from production, excluding metals purchased from stock).

4.3.2.1 SHELLS, HEADS AND CONDENSER PLATES

Thickness tolerances	Nominal thickness specified		Minimal thickness specified	
	Minus	Plus	Minus	Plus
CLADDING	TC ^M	TC ^P + 0,5	0	TC ^M + TC ^P + 0,5
BASE	TB ^M	TB ^P + 1	0	TB ^M + TB ^P + 1
TOTAL	TC ^M + TB ^M	TC ^P + TB ^P + 1,5	0	TC ^M + TC ^P + TB ^M + TB ^P + 1,5

TC^M = Minus tolerances as specified by cladding material standard

TC^P = Tolerances in plus as specified by cladding material standard

TB^M = Minus tolerances as specified by base material standard

TB^P = Tolerances in plus as specified by base material standard

4.3.2.2 TUBE SHEETS

Thickness	Nominal thickness specified	Minimal thickness specified
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tolerances	Minus	Plus	Minus	Plus
CLADDING	TC ^M	TC ^P + 2	0	TC ^M + TC ^P + 2
BASE	TB ^M	TB ^P + 5	0	TB ^M + TB ^P + 5
TOTAL	TC ^M + TB ^M	TC ^P + TB ^P + 7	0	TC ^M + TC ^P + TB ^M + TB ^P + 7

TC^M = Minus tolerances as specified by cladding material standard

TC^P = Tolerances in plus as specified by cladding material standard

TB^M = Minus tolerances as specified by base material standard

TB^P = Tolerances in plus as specified by base material standard

4.3.2.3 DOUBLE-SIDE CLAD PLATES AND MULTILAYER CLAD PLATES

For double-side clad plates, the thickness tolerance for base material shall be agreed upon with the manufacturer.

For multi-layer clad plates, the thickness tolerance for interlayer material(s) shall be agreed upon with the manufacturer.

4.3.3. FLATNESS

MEASUREMENT PROCEDURE FOR PLATES AND APPLICABLE FLATNESS TOLERANCES

Unless otherwise specified, flatness shall be measured on the cladding face of the composite clad. Measurement shall comply with the method described in standard EN 10029.

Two criteria are proposed. Unless otherwise specified, the "standard tolerances" of § 4.3.3.1 shall be applicable.

4.3.3.1 STANDARD TOLERANCES

Thickness-mm(") Length mm (")	15 < t (0.6")	15 ≤ t < 20 (0.8")	20 ≤ t < 50 (2")	50 ≤ t < 150 (6")	150 ≤ t
ℓ < 1500 (60")	(0.4") 10 mm/m	(0.3") 8 mm/m	(0.3") 7 mm/m	(0.3") 7 mm/m	To be agreed prior to order
1500 ≤ ℓ ≤ 3200	(0.5") 12 mm/m	(0.3") 8 mm/m	(0.3") 7 mm/m	(0.3") 7 mm/m	To be agreed prior to order
3200 ≤ ℓ ≤ 4500	(0.5") 12 mm/m	(0.4") 10 mm/m	(0.4") 10 mm/m	(0.4") 10 mm/m*	To be agreed prior to order
ℓ > 4500 (177")	Not applicable	To be agreed prior to order	To be agreed prior to order	To be agreed prior to order	To be agreed prior to order

* To be agreed over 3300 mm wide and 80 mm thick prior to order

4.3.3.2 SPECIAL TOLERANCES

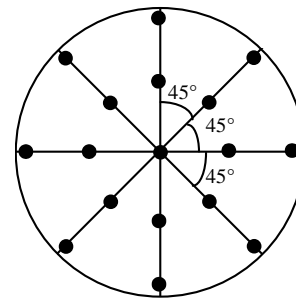
Thickness-mm(") Length-mm(")	15 < t	15 ≤ t < 20	20 ≤ t < 50	50 ≤ t < 150	150 ≤ t
ℓ < 1500 (60")	(0.4") 10 mm/m	(0.2") 5 mm/m	(0.15") 4 mm/m	(0.1") 3 mm/m	To be agreed prior to order
1500 ≤ ℓ ≤ 3200	(0.5") 12 mm/m	(0.2") 5 mm/m	(0.15") 4 mm/m	(0.1") 3 mm/m	To be agreed prior to order
ℓ > 3200 (126")	Not applicable	To be agreed prior to order	(0.15") 4 mm/m	(0.2") 6 mm/m*	To be agreed prior to order

* To be agreed over 3300-mm (130") wide and 80 mm (3") thick prior to order

4.3.3.3 MEASUREMENT PROCEDURE FOR TUBESHEETS AND APPLICABLE FLATNESS TOLERANCES

Measurement shall be made parallel to a reference plane.

The piece is placed base down on the flat reference surface. The measurement shall be made on 4 diameters with 5 measurement points per diameter (see Sketch).



Observed values correspond to the measurements made through optical sights.

Measurement precision is 0.5 mm (0.02"). Applicable criteria for the maximum deviation are described hereunder.

● : Measure point if diameter > 1000 mm (39"). Otherwise, measures shall be taken in the centre and in 4 points spread through the disc.

Thickness-mm(") Diameter - m (")	Maximum deviation in millimetres for D in meters (")	
	(0.8") 20 < t ≤ 30 (1")	30 < t ≤ 180 (7")
D < 1.8 (71")	3 x D	2 x D
1.8 ≤ D < 2.5 (98")	3 x D	2 x D
2.5 ≤ D < 3.2 (126")	3 x D	3 x D
D ≥ 3.2 (126")	To be agreed	3 x D

4.3.3.4 MEASUREMENT PROCEDURE FOR CONDENSER TUBESHEETS AND APPLICABLE FLATNESS TOLERANCES

Measurement shall be made parallel to a reference plane. The piece is placed base down, on the flat reference surface. The measurements shall be taken in the squares corners of a grid 700 x 700 mm (27.5" x 27.5"). Observed values correspond to the measurements made through sights. Measurement precision is 0.5 mm (0.02").

Applicable criteria for flatness and maximum deviation are described hereunder:

Thickness -mm(") Width-mm (")	(0.8") 20 < t ≤ 30 mm (1")		30 < t ≤ 60 mm (2")	
	Flatness mm/m	Deviation (mm)	Flatness mm/m	Deviation (mm)
ℓ < 2500 (98")	4 (0.15")	8 (0.3")	3 (0.1")	6 (0.2")
2500 ≤ ℓ < 3200 (100")	4 (0.15")	10 (0.4")	3 (0.1")	6 (0.2")
3200 ≤ ℓ < 4000 (138")	5 (0.2")	12 (0.47")	4 (0.15")	7 (0.4")
4000 ≤ ℓ < 4500 (177")	5 (0.2")	14 (0.6")	4 (0.15")	10 (0.47")
ℓ ≥ 4500	To be agreed	To be agreed	To be agreed	To be agreed

4.3.3.5 EXCEPTION

Different flatness measurement methods, together with particular flatness criteria can be specified on a case by case basis, after the manufacturer's agreement.

4.4. SURFACE FINISHES

4.4.1. AS-BONDED CONDITION

Unless otherwise the explosion clad plates and discs shall be supplied in "as bonded" condition.

Both sides, in the "as-rolled" and "as-bonded" condition, shall be delivered without any surface treatment (grinding or sandblasting). Local spot grinding and/or minor surface defects shall be allowed provided thickness tolerances are respected.

4.4.2. SMOOTH GRINDING

The cladding face shall be smoothly ground all over using grade 80 grit, in order to clean the surface after manufacturing operations.

4.4.3. GRINDING

The cladding face shall be ground all over using grade 80 grit. Mean surface-finishing Ra shall be below 3.2 µm. Spot grinding and/or surface defects shall be allowed, provided they do not result in under-thickness'.

4.4.4. SAND BLASTING

The base face (only) shall be sandblasted before shipment.

4.4.5. ANTI RUST

Anti rust painting shall be applied on base material (only) before shipment.

4.4.6. PROTECTIVE LAYER

An Arbo-Peelcoat protective layer shall be applied on the cladding face. (This painting should be removed prior to drilling, in case of tube-sheets).

4.4.7. MACHINING OF DISCS

4.4.7.1 CLADDING FACE

The cladding face shall be machined with lathe. Surface finishing Ra shall be below 3.2 µm. (This operation can also be carried out on plates with prior mutual agreement).

4.4.7.2 BASE SIDE.

The base face shall be machined with lathe. Surface finishing Ra shall be below 3.2 µm. (This operation can also be carried out on plates with prior mutual agreement).

4.4.7.3 THICKNESS TOLERANCE

Unless otherwise, the thickness tolerance shall be - 0 / + 2 mm

4.4.8. SPECIAL OPERATIONS

4.4.8.1.DRILLING

The exact drawing for drilling should be furnished before any quotation can be made. Specification to be agreed between manufacturer and purchaser.

4.4.8.2 HEAD FORMING

The exact drawing and specification should be submitted to the manufacturer. Specification to be agreed between manufacturer and purchaser.

4.4.8.3 SHELL FORMING

The exact drawing and specification should be submitted to the manufacturer. Specification to be agreed between manufacturer and purchaser.

4.4.8.4 OTHERS

Other machining can be considered upon agreement of the manufacturer.

4.5. MARKING

Unless otherwise specified, clad plates shall be cold marked on the base side (stamping, painting or adhesive), in order to identify them in compliance with the relevant mill test certificate. This marking shall include the clad plate number and Nobelclad die stamp.

5 - TESTING

Mechanical tests after cladding shall be performed when applicable (according to the individual metal standards). Purchaser shall indicate on his order all tests to be performed prior to, and after, cladding. Unless otherwise specified, no further mechanical test shall be performed on metals by the manufacturer, neither prior or after cladding.

5.1. NON DESTRUCTIVE TESTS

5.1.1. ULTRASONIC EXAMINATION

5.1.1.1 Ultrasonic examination generally refers to ASME SA 578, SEL 072 or NFA 04 305.

Bonded metals shall be ultrasonically tested on the cladding metal side to ensure the overall correct bonding of metals. Equipment shall consist of a pulse-echo direct-contact type with a transducer of a diameter 25-mm (1") or less.

The composite structure shall be considered "non bonded" when a complete loss of back reflection, together with an echo indication from the interface of the composite plate, shall be noted. When detected, any non-bond area shall be fully explored to determine its extent. Any other definitions can only be accepted with the manufacturer's written agreement.

SCANNING

Unless otherwise specified, plates shall be ultrasonically tested according to the standard methods described in SA 578 standard, from the cladding metal. Otherwise, the scanning shall be defined according to the purchaser's technical requirements.

ACCEPTANCE STANDARDS

Three levels are applicable:

	Types of Products	Maximum individual non bonded area	Percentage of bonded surface
LEVEL 1	Plates	44 cm ²	96 %
LEVEL 2	Tube sheets	5 cm ²	98 %
LEVEL 3	Condenser tube sheets	1 cm ² in drilled area 25cm ² outside drilled area	99 %

5.1.1.2 Other ultrasonic examination or criteria may be used upon agreement between the purchaser and the manufacturer.

5.1.1.3 The manufacturer according to his internal procedures and with the agreement of the purchaser can perform repairs of clad plates (weld overlay is applicable for stainless steel and nickel alloys cladding whereas partial bonding is used for other cladding materials)

5.1.2. FERROXYL TEST

Potassium Ferricyanide test, so-called "ferroxyl test", can be performed upon request according to Nobelclad internal procedure. No iron contamination shall be accepted on the cladding surface.

5.1.3. LIQUID PENETRANT EXAMINATION

When specified by purchaser, liquid penetrant examination can be carried out on the cladding plate, according to ASME VIII Division 1, Appendix 8.

5.1.4. Other tests can be carried with the manufacturer's agreement.

5.2. DESTRUCTIVE TESTS

TEST SPECIMEN

Test specimen shall be taken from each parent plate, either from an edge or from a corner of the plate.

Upon request, tests shall be performed on heat-treated test coupons.

Note: for forged base material and after purchaser's agreement, test specimen shall be taken from a separate coupon (thickness 60-mm - 2"), representative of each clad lot. A lot shall be defined by:

- The base metal
- The cladding metal
- the cladding thickness
- the heat treatment cycle or PWHT

The test coupon shall be clad with the same parameters used for the main forged pieces.

Other arrangements can be agreed between purchaser, and manufacturer.

5.2.1. SHEAR TEST

Bond shear strength shall be determined by test procedure described in ASTM B 898 or A 264. The test specimen shall be machined as per sketch 2 (in annexe).

ACCEPTANCE LEVELS

- 5.2.1.1 Stainless steel, nickel, nickel alloys, "Monel", **210 MPa** minimum
"Inconel", "Incoloy" and "Hastelloy" alloys
- 5.2.1.2 Zirconium, titanium, copper alloys **140 MPa** minimum
(Copper-aluminium, copper-nickel, naval brass)
- 5.2.1.3 Commercially pure copper **100 MPa** minimum

5.2.2. BEND TEST

Specimen subject to mechanical test shall be machined to the dimensions as per sketch 1 (in annexe).

5.2.2.1 BEND TEST IN TENSION (*FACE BEND TEST*)

Unless otherwise specified, the test shall be performed according to the applicable method defined in the ASTM B 898 or A 263 standard. The bend test specimen shall be bent around a pin. The diameter of the spin shall be equal to the greater of the diameters specified in the metals standards. The cladding metal shall be in tension outside. After bending, the test specimen shall not show any crack on the outside.

5.2.2.2 BEND TEST IN COMPRESSION (*REVERSE BEND TEST*)

Unless otherwise specified, the test shall be performed according to the applicable method defined in the ASTM B 898 or A 263 standard. The bend test specimen shall be bent around a pin. Its diameter shall be specified in standards for the base metal. The cladding metal shall be in compression inside. After bending, the test specimen shall not show any crack on the outside.

5.2.2.3 SIDE BEND TEST

The test shall be performed according to the method defined in the AD W8 standard.

5.2.3. TENSILE TEST

The tensile test shall be performed according to the procedure described in the ADW8 or ASTM B 898 standards. Unless special agreement, the test shall be performed on the base metal only.

	Composite Tensile Test (ADW8)	Base Material Tensile Test
Minimum tensile strength	Minimum value defined by the ADW8 formula	Specified minimum tensile strength of base metal
Guaranteed minimum elongation	Lower value of specified minimum elongation of cladding and base metals	Specified minimum elongation of base metal

For the composite specimen, the total thickness can be reduced provided the original cladding and base metal ratio remain the same.

5.2.4. NOTCH IMPACT TEST

When specified by purchaser, notch impact tests can be performed after cladding, on the base metal only, according to the base metal standards. Without this precision, notch impact test will be carried out only before cladding.

5.2.5. MICROGRAPHY

Micrography can be carried out upon manufacturer's agreement.

5.2.6. MACROGRAPHY

Macrography can be carried out upon manufacturer's agreement.

5.2.7. HARDNESS TEST

When specified by purchaser, hardness measurements can be carried out, especially on weld seam as per ASTM E-92. The purchaser shall agree with the manufacturer where to take the test specimen and the measurement point(s).

5.2.8. Other tests can be carried out upon manufacturer's agreement.

6 – INSPECTION CERTIFICATES

The clad plates under this specification may be ordered with or without independent inspector. When specified, the inspection shall be made at the place of manufacture prior to shipment.

In all cases, the clad plates shall always be supplied with the metals test certificates in accordance with one of the subsections of section 7.2.

6.1. INSPECTION OF MATERIALS BEFORE CLADDING

The inspection of the metals shall be made in accordance with the applicable standards. Results shall be reported on a test certificate EN-10204-type. Certificates shall be chosen among the ones presented in EN 10204 European Standard.

6.1.1. Type 2.1

6.1.2. Type 3.1.A

6.1.3. Type 3.1.B

6.1.4. Type 3.1.C

For 3.1.C., the purchaser has to specify the name of third party inspector.

6.2. INSPECTION OF CLAD PLATES

The clad plates are supplied with certificates according to EN 10204. The purchaser shall indicate the type of certificates requested for metals before cladding and for clad material, referring to following paragraphs

6.2.1. Type 2.1

6.2.2. Type 3.1.A

6.2.3. Type 3.1.B

6.2.4. Type 3.1.C

For 3.1.C., the purchaser has to specify the name of third party inspector.

7 – SHIPMENT PROTECTION

The explosion clad plates and discs shall be supplied with following proposed protection.

7.1. NO PACKING

The plates shall be loaded on trucks without specific protection on clad faces. In case of stacked plates, wooden packing pieces shall be inserted between each plate, and the packing shall be strapped.

7.2. "EUROPEAN" PACKING

A P.E. (polyethylene) film shall protect the clad side of plates. In case of stacked plates, wooden packing pieces shall be inserted between each plate, and the packing shall be strapped.

7.3. LIGHT PACKING FOR AIRFREIGHT

A P.E. film and hard board shall protect the clad side of plates. In case of stacked plates, wooden packing pieces shall be inserted between each plate, and the packing shall be strapped on a pallet.

7.4. OVERSEAS PACKING

A P.E. film and hard board shall protect the clad side of plates. Plates shall be stored in a strong wooden box with water-resistant packing suitable for vessel transportation (packaging complies with category IV of S.N.E.). This packing is especially applicable for long-term overseas transportation.

7.5. Pieces under 500 x 500 mm (20" x 20") are always packed in wooden boxes and protected by a P.E. film.

7.6. Other protections can be provided by prior mutual agreement.

8 - MISCELLENEOUS

8.1. QUALITY PLAN

A quality plan according to our Quality Manual can be submitted at request. It will be submitted within one month after receipt of order (or intended order).

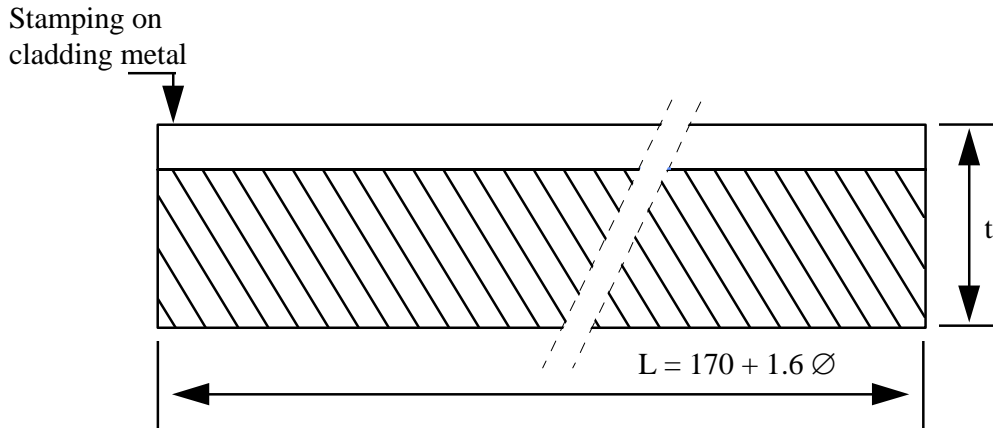
8.2. SCHEDULE PLAN

A schedule plan (bar chart) can be submitted at request. It will be submitted within one month after reception of order (or intended order).

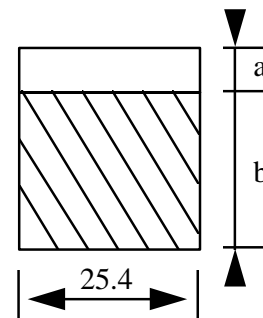
It will be revised weekly, after receipt of base and cladding material.

Any delay to metal deliveries will be notified.

SKETCH 1
Specimen for bend test

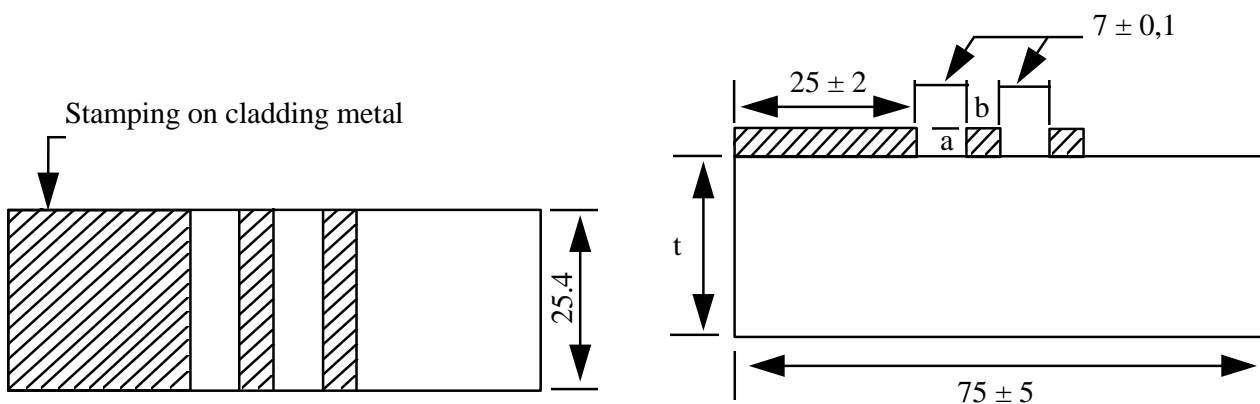


- Ø : diameter of the pin as specified in the applicable specification
- T : thickness of the specimen (25.4-mm - 1" - max.)
- a : thickness of the cladding metal
- b : thickness of the base metal
- L : specimen length
- Tolerances: a: ± 0.2 mm (0.008")
- other dimensions: ± 0.4 mm (0.02")



For plates over 25.4 mm in thickness (a + b), the specimen shall be machined down to 25.4 mm in thickness.
 In reducing the thickness, both the cladding and the base metals shall be machined so as to maintain the same ratio of clad metal to base metal as the one in the plate except that the thickness of the cladding metal shall not be reduced below 3.2 mm.

SKETCH 2
Specimen for shear test



- a : thickness of the cladding metal (3.2-mm maxi - 0.1")
- b : width of the cladding metal left
- b = 1.5 a
- t : thickness of the base metal (25.4-mm maxi)
- Tolerances: a and b: ± 0.1 mm
- Other dimensions: ± 0.4 mm

Note: all dimensions are in mm