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Designation: B 432 – 91 (Reapproved 1998)



Designation: B 432 – 04

Standard Specification for Copper and Copper Alloy Clad Steel Plate¹

This standard is issued under the fixed designation B 432; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

¹ This specification is under the jurisdiction of ASTM Committee B-5 B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

Current edition approved Nov. 15, 1994; May 1, 2004. Published January 1992; May 2004. Originally published as B 432 – 66; approved in 1966. Last previous edition B 432 – 76a (1989) ^{ε1}; approved in 1998 as B 432 – 91 (1998).

1. Scope*

1.1 This specification covers ~~base metal~~ plate of a carbon steel or low-alloy steel ~~base~~ to which a thickness of copper or copper alloy is ~~continuously and integrally and continuously~~ bonded on one or both sides:

~~1.2 The product~~ sides a layer of copper or copper-base alloy. The material is ~~designated single-clad plate~~ generally intended for pressure vessel use but may be used in other structural applications where corrosion resistance or ~~double-clad plate~~ depending upon whether one or both sides are clad.

~~1.3 This specification does not normally pertain to weld deposit clad plates.~~

~~1.4 The conductivity of the alloy is of prime importance.~~

1.2 The values stated in inch-pound units are to be regarded as the standard. The values SI units given in parentheses are for information only.

2. Referenced Documents

2.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

~~2.2~~

2.1 ASTM Standards: ²

A 2836/A 2836M Specification for ~~Low and Intermediate Tensile Strength Carbon~~ General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

A 2850/A 2850M Specification for General Requirements for Steel Plates for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength² Vessels

A 515/A 515M Specification for ~~Pressure Vessel Plates, Carbon Steel, for Intermediate-~~ 370 Test Methods and Higher-Temperature Service² Definitions for Mechanical Testing of Steel Products

A 51678/A 51678M Specification for ~~Pressure Vessel Plates, Carbon Steel, for Moderate-~~ Straight-Beam Ultrasonic Examination of Plain and Lower-Temperature Service² Clad Steel Plates for Special Applications

B 96 Specification for Copper-Silicon Alloy Plate, Sheet, Strip, and Rolled Bar for General Purposes and Pressure Vessels

B 152/B 152M Specification for Copper Sheet, Strip, Plate, and Rolled Bar

B 171/B 171M Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers, and Heat Exchangers³

~~B 402 Specification for Copper-Nickel Alloy Plate and Sheet for Pressure Vessels~~ Exchangers

E-8 Test Methods 29 Practice for ~~Tension Testing of Metallic Materials~~

E-29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards*; Vol 01.04; volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 ASME Code:

Boiler and Pressure Vessel Code, Section VIII³

Boiler and Pressure Vessel Code, Section IX, Welding Qualifications³

3. Terminology

3.1 ~~Definitions of Terms Specific to This Standard: Definitions:~~

3.1.1 ~~base metal (banching steel), n—component to which the cladding metal is applied, usually the greater percentage of flat product intended for subsequent fabrication by forming, bending, cupping, drawing, hot pressing, the composite plate and usually consisting of carbon or low-alloy steel.~~

3.1.2 ~~capable of—the term “capable of” blind flange, n—same as used in this specification means that the test need not be performed by the producer of the material. However, should subsequent testing by the purchaser establish that the material does not meet these requirements, the material shall be subject to rejection.—a cover.~~

3.1.3 ~~lengths—straight pieces cladding metal, n—the copper or copper-base alloy component of the product.~~

3.1.3.1 ~~specific—straight lengths that are uniform in length, as specified, and subject to established length tolerances.—composite plate.~~

3.1.4 ~~plate cover, n—a wrought, flat product component with similar features to a tubesheet which is used as a closure and which typically requires surface machining over part of the face while maintaining minimum specified minimum thickness.~~

3.1.5 ~~double-clad, n—material is considered as double-clad when both sides of the steel base metal are covered with copper cladding.~~

3.1.6 ~~interface, n—of the clad product, is that region of the thickness in which the product transitions from essentially 100 % base metal to 100 % cladding metal, also referred to as the bond or bondzone.~~

3.1.7 ~~integrally and continuously bonded, adv—a condition in which the cladding metal and base metal are brought together to form a metallurgical bond at essentially the entire interface of the two metals by means other than those processes that do not produce a homogeneous composite plate.~~

3.1.8 ~~plate, n—the term plate as used in this specification applies to material 0.188 in. (4.77 mm) thick and over 12 in thickness, and over 10 in. (254 mm) wide, in width.~~

3.1.9 ~~single-clad, n—material is considered as single-clad when only one side of the steel base metal is covered with copper cladding.~~

3.1.10 ~~tubesheet, n—a clad plate which is used in a heat exchanger to separate the tubeside and shell side components. Typically, but not necessarily, tubesheets are round, relatively thick, and require that the cladding and/or base be machined flat over part or all of the face while maintaining specified minimum thicknesses.~~

4. Ordering Information

4.1 ~~It is the responsibility of the purchaser to specify all requirements that are necessary for products material ordered under this specification. Such requirements may include, but are not limited to the following:~~

4.1.1 ~~Quantity (weight or number of pieces),~~

4.1.2 ~~Dimensions, including the thickness of product: clad steel plate (specify whether clad one or both sides) (1.2) the cladding alloy and for tube sheets when applicable;~~

4.1.3 ~~Base metal required (6.1.1);~~

4.1.4 ~~Cladding metal required (6.1.2);~~

4.1.5 ~~If tensile, bend, the backing steel, or shear tests are required (Section 9);~~

4.1.6 ~~Dimensions: diameter or length and width of the total composite plate, and if more or less restrictive thickness of each component (8.1 and 8.2);~~

4.1.7 ~~Whether product tolerances apply.~~

4.1.3 ~~Cladding metal specification (see Section 6),~~

4.1.4 ~~Base metal specification (see Section 6),~~

4.1.5 ~~Advise if the part is to be edge machined used as a tubesheet, cover, or flame cut (8.1.1 and 8.1.2),~~

4.1.8 ~~Flatness tolerance; blind flange,~~

4.1.6 ~~Shear testing requirements if required any (see 8.3);~~

4.1.9 ~~Specification number, and~~

4.1.10 ~~Whether ultrasonic testing Sections 7 and 8),~~

4.1.7 ~~Restrictions, if required, on repair by welding (see Section 11),~~

4.1.8 ~~Additions to the specification or special requirements.~~

4.2 ~~The purchaser is referred to the listed supplementary requirements in this specification and to the detailed requirements in Specifications A 20/A 20M or A 6/A 6M as applicable. If the requirements of this specification are in conflict with the requirements~~

Annual Book

³ Available from American Society of ASTM Standards, Vol 02.01: Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

of Specification A 20/A 20M or A 6/A 6M, the requirements of this specification shall prevail.

5. Materials and Manufacture

5.1 Process:

5.1.1 The steel shall be made by the open-hearth, electric-furnace (with separate degassing and refining optional), or basic-oxygen processes, or by secondary processes whereby steel made from these primary processes is remelted using, but not limited to electroslag remelting or vacuum arc remelting processes.

5.1.2 The cladding metal may be integrally and continuously bonded to the base metal by any method that will produce a metallurgically bonded clad steel conforming that will conform to the requirements of this specification.

5.1.3 Heat Treatment—Material shall be furnished in a condition that the manufacturer determines is most appropriate, unless a heat treatment is specified by the base metal specification, cladding material specification, or by mutual agreement between manufacturer and purchaser.

6. Chemical Composition

6.1 The clad plate shall conform to any desired combination of base metal and cladding metal components as described in 6.2 and 6.3, and as agreed upon between the following paragraphs:

6.1.1 purchaser and the manufacturer.

6.2 Base Metal—The base metal may be carbon steel or low-alloy steel, chemically steel conforming to an the ASTM specifications for steel plate. The chemical composition of a specified low-alloy steel not so covered shall be steels for either pressure vessels or general structural applications, or other, as agreed upon by the manufacturer or supplier purchaser and the purchaser. The base metal shall conform to the chemical requirements of the specification to which it is ordered.

6.1.2—

6.3 Cladding Metal—The cladding metal covered by this specification may include any copper or copper-base alloy that is cladding metal specified and shall be made according conform to an ASTM specification covering that copper or copper alloy. If an ASTM specification is not available for that copper or copper alloy, agreement between the purchaser and manufacturer must be obtained before fabrication of requirements as to chemical composition prescribed in the respective cladding metal Specifications B 96, B 152/B 152M, or B 171/B 171M, or other copper-base alloy specification as to chemical composition, mechanical properties, tolerances, agreed upon by the purchaser and so forth. manufacturer.

7. Mechanical Requirements

7.1 The product, after bonding, with cladding removed shall be capable of meeting the minimum mechanical properties required of the specified base steel plate.

7.2 The minimum shear strength of the bond between the alloy cladding and base metal shall be 12 ksi (85 MPa).

7.3 When required by the purchase order, the clad steel plate shall be ultrasonically tested for bond integrity. See Supplementary Requirements.

8. Dimensions and Permissible Variations

8.1 Diameter, or Length and Width

7.1 Tensile Property Requirements :

8.1.1 When clad plate is to

7.1.1 Tensile tests shall be supplied in performed on the edge machined condition, the following tolerances base metal only.

7.1.2 Tensile tests shall apply:

Diameter, or Length and Width	Tolerance, Plus and Minus
Under 60 in. (1.52 m)	1/16 in. (1.6 mm)
60 to 84 in. (1.52 to 2.13 m)	1/8 in. (3.2 mm)
60 conform to 84 in. (1.52 to 2.13 m)	1/8 in. (3.2 mm)

8.1.2 When clad plate is to be supplied flame cut, tolerances shall be as agreed upon between purchaser and supplier.

8.2 Thickness—Components the requirements of clad plate shall be supplied in any standard gage with standard tolerances. Special gages and tolerances may be supplied by special arrangement.

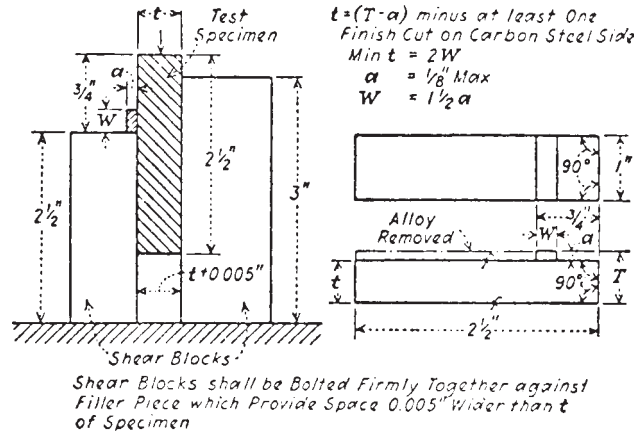
8.3 Flatness the Base Metal Specification.

7.2 Bond Strength Requirements :

8.3.1 The flatness

7.2.1 Shear Strength Test—When required by the purchaser, the minimum shear strength of clad plate to the interface shall be used as tube sheets 12 000 psi (84 MPa). The shear test, when specified, shall be measured on made in the manner indicated in Fig. 1. The shear test is not applicable when the specified minimum cladding component side across thickness is 0.075 in. (1.9 mm) or less.

7.2.2 Alternate Bond Strength Test—As an alternative to the diameter of the circular tube sheet shear strength test provided in 7.2.1 or when agreed upon by the width purchaser and the manufacturer, three bend tests shall be made with the alloy cladding



SI Equivalents

in.	mm	in.	mm
0.005	0.127	4	25.4
0.005	0.127	1	25.4
1/8	3.18	2 1/2	63.5
1/8	3.18	2 1/2	63.5
3/4	19.1	3	76.2

FIG. 3 1 Test Specimen and Method of Making Shear Test of Clad Plate

in compressions to determine the quality of a rectangular tube sheet the bond. These bend tests shall be made using 1.5 in (38 mm) wide by full thickness specimens and shall conform to the applicable tolerances bend diameters provided for in Table 1. Variations in flatness along the lengths base metal specification. At least two of plate up to 18 ft (5.5 m) in length or along any 12-ft (3.7-m) length of plate longer the three tests shall show not more than 18 ft (5.5 m) 50 % separation on both edges of the bent portion. Greater separation shall be cause for rejection. The bond strength bend test is generally not exceed tabular amount specified recommended for cladding thicknesses where the shear test ids applicable.

7.3 Test specimens may be taken at the manufacturer's option from the excess portion of plate.

8.3.2 The flatness tolerance (maximum concavity across width the material after the final cut to size or length) from separate pieces produced from the same heat under the same manufacturing conditions.

7.4 Additional mechanical tests may be performed. See Supplementary Requirements.

8. Number of rectangular clad plate intended for purposes other than tube sheet shall conform to Table 2 Tests and Retests

8.1 One or more tension tests, as required by the base metal specification, and when specified, one shear test or three bond strength bend tests, as applicable, shall be agreed upon between purchaser and producer.

8.3.3 Measurement of flatness made, representing each manufacturing lot. Each specimen shall be made by placing in the plate on a flat surface, applying a straight edge across final condition of heat treatment required for the plate, including any SPWHT (Simulated Post Weld Heat Treatment) if required, Supplementary Requirement S3. A manufacturing lot shall be defined as all product from each base plate as-rolled which is clad under the depth of arc between the straight edge same conditions.

8.2 If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

9. Workmanship, Finish, and Appearance Test Specimens

9.1 The material tension test specimens shall conform to the requirements prescribed in the specifications for the base metal.

TABLE 1 Flatness Tolerances for Tube Sheets, Clad One Side Only^A

Total Thickness, in. (mm)	Maximum Deviation from True Flatness ^B for a Given Diameter, Width, or Length, in. (mm)				
	To 48 (1219)	Over 48 (1219) to 72 (1829)	Over 72 (1829) to 96 (2438)	Over 96 (2438) to 120 (3048)	Over 120 (3048)
To 2 1/2 (63.5)	1/8 (3.18)	1/8 (3.18)	3/16 (4.76)	1/4 (6.35)	1/2 (12.7)
Over 2 1/2 (63.5) to 4 (102)	1/8 (3.18)	1/8 (3.18)	1/4 (6.35)	1/2 (12.7)	1/2 (12.7)
Over 4 (102) to 6 (152)	1/8 (3.18)	1/4 (6.35)	3/8 (9.52)	1/2 (12.7)	1/2 (12.7)
Over 6 (152) to 8 (203)	3/16 (4.76)	3/8 (9.52)	1/2 (12.7)	1/2 (12.7)	1/2 (12.7)

^A Two side clads by special arrangement.

^B Measured distance from an imaginary plane representing the best fit to the part surface. Measurement methods may include, but are not limited to, planar grids, planar referencial wheels, setup on a maced-ehining table-p, or latser surveying.

TABLE 2 Flatness Tolerances for Plate Other than Tube Sheets
Note 1—Flatness Variations for Length—The longer dimension specified is considered the length, and variation in flatness along the length should not exceed the tabular amount for the specified width in plates up to 12 ft (3.66 m) in length or in any 12 ft (3.66 m) of longer plates.

NOTE 2—Flatness Variations for Width— The flatness variation across the width should not exceed the tabular amount for the specified width.

NOTE 3— WHEN THE LONGER DIMENSION IS UNDER 36 IN. (916 MM), THE VARIATION IN FLATNESS ALONG THE LENGTH AND ACROSS THE WIDTH SHOULD NOT EXCEED 1/4 IN. (6.35 MM) IN EACH DIRECTION. WHEN THE LONGER DIMENSION IS FROM 36 TO 72 IN. (916 TO 1832 MM), INCLUSIVE, THE FLATNESS VARIATION SHOULD NOT EXCEED 75 % OF THE TABULAR AMOUNT FOR THE SPECIFIED WIDTH, BUT IN NO CASE LESS THAN 1/4 IN. (6.35 MM).

NOTE 4— The tolerances given in the above table apply to plates which have a minimum specified tensile strength not over 60 000 psi (415 a MPa) or compatible chemistry or hardness. For plates specified to a higher minimum tensile strength or compatible chemistry or hardness, the limits given in the table are increased in 1 1/2 times the amounts in the table below.

NOTE 5— The table below and notes cover the flatness tolerances of circular and sketch plates based on the maximum dimensions of those plates:

Specified Thickness, in.	Over Diameter to 36 in.	36 to 48 excl	48 to 60 excl	60 to 72 excl	72 to 84 excl	84 to 96 excl	96 to 108 excl	108 to 120 excl	120 to 144 excl	144 to 168 excl	168 and over, ±	Variations from a Flat Surface for Specified Widths, mm																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
												Over 203 to 916 excl	916 to 1219 excl	1219 to 1524 excl	1524 to 1829 excl	1829 to 2134 excl	2134 to 2438 excl	2438 to 2743 excl	2743 to 3048 excl	3048 to 3658 excl	3658 to 4267 excl	4267 to 4876 excl	4876 to 5485 excl	5485 to 6094 excl	6094 to 6703 excl	6703 to 7312 excl	7312 to 7921 excl	7921 to 8530 excl	8530 to 9139 excl	9139 to 9748 excl	9748 to 10357 excl	10357 to 10966 excl	10966 to 11575 excl	11575 to 12184 excl	12184 to 12793 excl	12793 to 13402 excl	13402 to 14011 excl	14011 to 14620 excl	14620 to 15229 excl	15229 to 15838 excl	15838 to 16447 excl	16447 to 17056 excl	17056 to 17665 excl	17665 to 18274 excl	18274 to 18883 excl	18883 to 19492 excl	19492 to 20101 excl	20101 to 20710 excl	20710 to 21319 excl	21319 to 21928 excl	21928 to 22537 excl	22537 to 23146 excl	23146 to 23755 excl	23755 to 24364 excl	24364 to 24973 excl	24973 to 25582 excl	25582 to 26191 excl	26191 to 26800 excl	26800 to 27409 excl	27409 to 28018 excl	28018 to 28627 excl	28627 to 29236 excl	29236 to 29845 excl	29845 to 30454 excl	30454 to 31063 excl	31063 to 31672 excl	31672 to 32281 excl	32281 to 32890 excl	32890 to 33499 excl	33499 to 34108 excl	34108 to 34717 excl	34717 to 35326 excl	35326 to 35935 excl	35935 to 36544 excl	36544 to 37153 excl	37153 to 37762 excl	37762 to 38371 excl	38371 to 38980 excl	38980 to 39589 excl	39589 to 40198 excl	40198 to 40807 excl	40807 to 41416 excl	41416 to 42025 excl	42025 to 42634 excl	42634 to 43243 excl	43243 to 43852 excl	43852 to 44461 excl	44461 to 45070 excl	45070 to 45679 excl	45679 to 46288 excl	46288 to 46897 excl	46897 to 47506 excl	47506 to 48115 excl	48115 to 48724 excl	48724 to 49333 excl	49333 to 49942 excl	49942 to 50551 excl	50551 to 51160 excl	51160 to 51769 excl	51769 to 52378 excl	52378 to 52987 excl	52987 to 53596 excl	53596 to 54205 excl	54205 to 54814 excl	54814 to 55423 excl	55423 to 56032 excl	56032 to 56641 excl	56641 to 57250 excl	57250 to 57859 excl	57859 to 58468 excl	58468 to 59077 excl	59077 to 59686 excl	59686 to 60295 excl	60295 to 60904 excl	60904 to 61513 excl	61513 to 62122 excl	62122 to 62731 excl	62731 to 63340 excl	63340 to 63949 excl	63949 to 64558 excl	64558 to 65167 excl	65167 to 65776 excl	65776 to 66385 excl	66385 to 66994 excl	66994 to 67603 excl	67603 to 68212 excl	68212 to 68821 excl	68821 to 69430 excl	69430 to 70039 excl	70039 to 70648 excl	70648 to 71257 excl	71257 to 71866 excl	71866 to 72475 excl	72475 to 73084 excl	73084 to 73693 excl	73693 to 74302 excl	74302 to 74911 excl	74911 to 75520 excl	75520 to 76129 excl	76129 to 76738 excl	76738 to 77347 excl	77347 to 77956 excl	77956 to 78565 excl	78565 to 79174 excl	79174 to 79783 excl	79783 to 80392 excl	80392 to 81001 excl	81001 to 81610 excl	81610 to 82219 excl	82219 to 82828 excl	82828 to 83437 excl	83437 to 84046 excl	84046 to 84655 excl	84655 to 85264 excl	85264 to 85873 excl	85873 to 86482 excl	86482 to 87091 excl	87091 to 87700 excl	87700 to 88309 excl	88309 to 88918 excl	88918 to 89527 excl	89527 to 90136 excl	90136 to 90745 excl	90745 to 91354 excl	91354 to 91963 excl	91963 to 92572 excl	92572 to 93181 excl	93181 to 93790 excl	93790 to 94399 excl	94399 to 95008 excl	95008 to 95617 excl	95617 to 96226 excl	96226 to 96835 excl	96835 to 97444 excl	97444 to 98053 excl	98053 to 98662 excl	98662 to 99271 excl	99271 to 99880 excl	99880 to 100489 excl	100489 to 101098 excl	101098 to 101707 excl	101707 to 102316 excl	102316 to 102925 excl	102925 to 103534 excl	103534 to 104143 excl	104143 to 104752 excl	104752 to 105361 excl	105361 to 105970 excl	105970 to 106579 excl	106579 to 107188 excl	107188 to 107797 excl	107797 to 108406 excl	108406 to 109015 excl	109015 to 109624 excl	109624 to 110233 excl	110233 to 110842 excl	110842 to 111451 excl	111451 to 112060 excl	112060 to 112669 excl	112669 to 113278 excl	113278 to 113887 excl	113887 to 114496 excl	114496 to 115105 excl	115105 to 115714 excl	115714 to 116323 excl	116323 to 116932 excl	116932 to 117541 excl	117541 to 118150 excl	118150 to 118759 excl	118759 to 119368 excl	119368 to 119977 excl	119977 to 120586 excl	120586 to 121195 excl	121195 to 121804 excl	121804 to 122413 excl	122413 to 123022 excl	123022 to 123631 excl	123631 to 124240 excl	124240 to 124849 excl	124849 to 125458 excl	125458 to 126067 excl	126067 to 126676 excl	126676 to 127285 excl	127285 to 127894 excl	127894 to 128503 excl	128503 to 129112 excl	129112 to 129721 excl	129721 to 130330 excl	130330 to 130939 excl	130939 to 131548 excl	131548 to 132157 excl	132157 to 132766 excl	132766 to 133375 excl	133375 to 133984 excl	133984 to 134593 excl	134593 to 135202 excl	135202 to 135811 excl	135811 to 136420 excl	136420 to 137029 excl	137029 to 137638 excl	137638 to 138247 excl	138247 to 138856 excl	138856 to 139465 excl	139465 to 140074 excl	140074 to 140683 excl	140683 to 141292 excl	141292 to 141901 excl	141901 to 142510 excl	142510 to 143119 excl	143119 to 143728 excl	143728 to 144337 excl	144337 to 144946 excl	144946 to 145555 excl	145555 to 146164 excl	146164 to 146773 excl	146773 to 147382 excl	147382 to 147991 excl	147991 to 148600 excl	148600 to 149209 excl	149209 to 149818 excl	149818 to 150427 excl	150427 to 151036 excl	151036 to 151645 excl	151645 to 152254 excl	152254 to 152863 excl	152863 to 153472 excl	153472 to 154081 excl	154081 to 154690 excl	154690 to 155299 excl	155299 to 155908 excl	155908 to 156517 excl	156517 to 157126 excl	157126 to 157735 excl	157735 to 158344 excl	158344 to 158953 excl	158953 to 159562 excl	159562 to 160171 excl	160171 to 160780 excl	160780 to 161389 excl	161389 to 162000 excl	162000 to 162609 excl	162609 to 163218 excl	163218 to 163827 excl	163827 to 164436 excl	164436 to 165045 excl	165045 to 165654 excl	165654 to 166263 excl	166263 to 166872 excl	166872 to 167481 excl	167481 to 168090 excl	168090 to 168700 excl	168700 to 169309 excl	169309 to 169918 excl	169918 to 170527 excl	170527 to 171136 excl	171136 to 171745 excl	171745 to 172354 excl	172354 to 172963 excl	172963 to 173572 excl	173572 to 174181 excl	174181 to 174790 excl	174790 to 175400 excl	175400 to 176009 excl	176009 to 176618 excl	176618 to 177227 excl	177227 to 177836 excl	177836 to 178445 excl	178445 to 179054 excl	179054 to 179663 excl	179663 to 180272 excl	180272 to 180881 excl	180881 to 181490 excl	181490 to 182100 excl	182100 to 182709 excl	182709 to 183318 excl	183318 to 183927 excl	183927 to 184536 excl	184536 to 185145 excl	185145 to 185754 excl	185754 to 186363 excl	186363 to 186972 excl	186972 to 187581 excl	187581 to 188190 excl	188190 to 188800 excl	188800 to 189409 excl	189409 to 190018 excl	190018 to 190627 excl	190627 to 191236 excl	191236 to 191845 excl	191845 to 192454 excl	192454 to 193063 excl	193063 to 193672 excl	193672 to 194281 excl	194281 to 194890 excl	194890 to 195500 excl	195500 to 196109 excl	196109 to 196718 excl	196718 to 197327 excl	197327 to 197936 excl	197936 to 198545 excl	198545 to 199154 excl	199154 to 199763 excl	199763 to 200372 excl	200372 to 200981 excl	200981 to 201590 excl	201590 to 202200 excl	202200 to 202809 excl	202809 to 203418 excl	203418 to 204027 excl	204027 to 204636 excl	204636 to 205245 excl	205245 to 205854 excl	205854 to 206463 excl	206463 to 207072 excl	207072 to 207681 excl	207681 to 208290 excl	208290 to 208900 excl	208900 to 209509 excl	209509 to 210118 excl	210118 to 210727 excl	210727 to 211336 excl	211336 to 211945 excl	211945 to 212554 excl	212554 to 213163 excl	213163 to 213772 excl	213772 to 214381 excl	214381 to 214990 excl	214990 to 215600 excl	215600 to 216209 excl	216209 to 216818 excl	216818 to 217427 excl	217427 to 218036 excl	218036 to 218645 excl	218645 to 219254 excl	219254 to 219863 excl	219863 to 220472 excl	220472 to 221081 excl	221081 to 221690 excl	221690 to 222300 excl	222300 to 222909 excl	222909 to 223518 excl	223518 to 224127 excl	224127 to 224736 excl	224736 to 225345 excl	225345 to 225954 excl	225954 to 226563 excl	226563 to 227172 excl	227172 to 227781 excl	227781 to 228390 excl	228390 to 229000 excl	229000 to 229609 excl	229609 to 230218 excl	230218 to 230827 excl	230827 to 231436 excl	231436 to 232045 excl	232045 to 232654 excl	232654 to 233263 excl	233263 to 233872 excl	233872 to 234481 excl	234481 to 235090 excl	235090 to 235700 excl	235700 to 236309 excl	236309 to 236918 excl	236918 to 237527 excl	237527 to 238136 excl	238136 to 238745 excl	238745 to 239354 excl	239354 to 239963 excl	239963 to 240572 excl	240572 to 241181 excl	241181 to 241790 excl	241790 to 242400 excl	242400 to 243009 excl	243009 to 243618 excl	243618 to 244227 excl	244227 to 244836 excl	244836 to 245445 excl	245445 to 246054 excl	246054 to 246663 excl	246663 to 247272 excl	247272 to 247881 excl	247881 to 248490 excl	248490 to 249100 excl	249100 to 249709 excl	249709 to 250318 excl	250318 to 250927 excl	250927 to 251536 excl	251536 to 252145 excl	252145 to 252754 excl	252754 to 253363 excl	253363 to 253972 excl	253972 to 254581 excl	254581 to 255190 excl	255190 to 255800 excl	255800 to 256409 excl	256409 to 257018 excl	257018 to 257627 excl	257627 to 258236 excl	258236 to 258845 excl	258845 to 259454 excl	259454 to 260063 excl	260063 to 260672 excl	260672 to 261281 excl	261281 to 261890 excl	261890 to 262500 excl	262500 to 263109 excl	263109 to 263718 excl	263718 to 264327 excl	264327 to 264936 excl	264936 to 265545 excl	265545 to 266154 excl	266154 to 266763 excl	266763 to 267372 excl	267372 to 267981 excl	267981 to 268590 excl	268590 to 269200 excl	269200 to 269809 excl	269809 to 270418 excl	270418 to 271027 excl	271027 to 271636 excl	271636 to 272245 excl	272245 to 272854 excl	272854 to 273463 excl	273463 to 274072 excl	274072 to 274681 excl	274681 to 275290 excl	275290 to 275900 excl	275900 to 276509 excl	276509 to 277118 excl	277118 to 277727 excl	277727 to 278336 excl	278336 to 278945 excl	278945 to 279554 excl	279554 to 280163 excl	280163 to 280772 excl	280772 to 281381 excl	281381 to 281990 excl	281990 to 282600 excl	282600 to 283209 excl	283209 to 283818 excl	283818 to 284427 excl	284427 to 285036 excl	285036 to 285645 excl	285645 to 286254 excl	286254 to 286863 excl	286863 to 287472 excl	287472 to 288081 excl	288081 to 288690 excl	288690 to 289300 excl	289300 to 289909 excl	289909 to 290518 excl	290518 to 291127 excl	291127 to 291736 excl	291736 to 292345 excl	292345 to 292954 excl	292954 to 293563 excl	293563 to 294172 excl	294172 to 294781 excl	294781 to 295390 excl	295390 to 296000 excl	296000 to 296609 excl	296609 to 297218 excl	297218 to 297827 excl	297827 to 298436 excl	298436 to 299045 excl	299045 to 299654 excl	299654 to 300263 excl	300263 to 300872 excl	300872 to 301481 excl	301481 to 302090 excl	302090 to 302700 excl	302700 to 303309 excl	303309 to 303918 excl	303918 to 304527 excl	304527 to 305136 excl	305136 to 305745 excl	305745 to 306354 excl	306354 to 306963 excl	306963 to 307572 excl	307572 to 308181 excl	308181 to 308790 excl	308790 to 309400 excl	309400 to 310009 excl	310009 to 310618 excl	310618 to 311227 excl	311227 to 311836 excl	311836 to 312445 excl	312445 to 313054 excl	313054 to 313663 excl	313663 to 314272 excl	314272 to 314881 excl	314881 to 315490 excl	315490 to 316100 excl	316100 to 316709 excl	316709 to 317318 excl	317318 to 317927 excl	317927 to 318536 excl	318536 to 319145 excl	319145 to 319754 excl	319754 to 320363 excl	320363 to 320972 excl	320972 to 321581 excl	321581 to 322190 excl	322190 to 322800 excl	322800 to 323409 excl	323409 to 324018 excl	324018 to 324627 excl	324627 to 325236 excl	325236 to 325845 excl	325845 to 326454 excl	326454 to 327063 excl	327063 to 327672 excl	327672 to 328281 excl	328281 to 328890 excl	328890 to 329500 excl	329500 to 330109 excl	330109 to 330718 excl	330718 to 331327 excl	331327 to 331936 excl	331936 to 332545 excl	332545 to 333154 excl	333154 to 333763 excl	333763 to 334372 excl	334372 to 334981 excl

when there is sufficient cladding thickness available so that there is no contamination from separate pieces produced under the same specification and temper.

~~10.3 When adjacent base metal.~~

~~10.3 If product analysis is specified by the bend test samples are purchaser for the cladding alloy, it shall be made on a sample taken from the finished product or a broken test specimen. For wet chemical analysis, in order to be supplied, these avoid contamination by the base plate metal, millings of cladding samples shall be taken from the middle test coupon by removal and discard of one end all the base metal plus 40 % of the p cladding thickness from the bonded side, not to exceed 0.063 in. (1.6 mm). The material shall be cleaned and sufficient millings taken to represent the axis full cross-section of the test coupon remainder.~~

~~10.4 The results of the product analysis shall be transverse conform to the major axis requirements of rolling the cladding metal and base metal specifications, as applicable.~~

~~10.5 Results of the product analysis for the backing steel when required shall conform to the requirements of Section 7 of Specification A 20/A 20M or A 6/A 6M, as applicable.~~

11. Number Dimensions and Permissible Variations

~~11.1 Unless otherwise specified herein, permissible variations except for thickness shall be in accordance with Specification A 20/A 20M or A 6/A 6M as applicable based on the base metal specification.~~

~~11.2 Minimum thickness of Tests~~

~~11.1 When specified, one the alloy cladding metal and of the backing steel, or more tension tests, of the total composite plate, shall be as required by purchase order documents when ordered to minimum thickness.~~

~~11.3 Permissible variation in thickness when ordered to nominal thicknesses shall be 0.01 in. (0.3 mm) under each for backing steel or total composite, and 0.03 in. (0.8 mm) under for the specification alloy cladding.~~

~~11.4 Permissible variations for excess thickness of the total composite shall be the greater of 0.125 in. (3 mm) or 10 % of the total composite thickness ordered and may occur in either backing steel, cladding, or both, provided the minimum for each is met.~~

~~11.5 When the product is specified for use as tubesheets, covers, or blind flanges in the ordering information, the flatness tolerances of Table 1 shall apply, otherwise flatness shall be in accordance with A 20/A 20M or A 6/A 6M as applicable based on the base metal one face bend test (cladding metal specification).~~

~~11.6 When the product is specified for use as tubesheets, covers, or blind flanges in tension), one reverse bend test (cladding metal in compression); the ordering information and a machined edge condition is specified, the diameter tolerances of Table 2 shall apply.~~

~~11.7 More restrictive or less restrictive permissible variations may be m agreed upon by the purchaser and the manufacturer.~~

12. Test Specimens

~~12.1 Tension Workmanship, Finish and bend test specimens Appearance~~

~~12.1 The material shall conform to the requirements prescribed in the specification for the base metal:~~

~~12.1.1 For base plates 1½ in. (38.1 mm) and under in thickness, tension and bend test specimens shall be the full thickness free of the material injurious defects and shall be machined to the form and dimensions shown in Fig. 1, or the bend test specimens may be machined with both edges parallel. The sides of the bend test specimen may have the corners rounded to a radius not over ¼ in. (1.59 mm):~~

~~12.1.2 For base plates over 1½ in. (38.1 mm) in thickness, tension and bend test specimens need not be greater in thickness than 1½ in. (38.1 mm), but shall not be less than 1½ in. (38.1 mm). The sides of workmanlike appearance.~~

~~12.2 Unless otherwise specified, the bend test specimen clad surface may have the corners rounded to a radius not over ¼ in. (3.2 mm). Specimens shall be in the form and dimensions shown in Fig. 2.~~

~~12.2 The shear test shall be made as indicated in Fig. 3. supplied as-rolled, ground, blasted (descaled by means of sand, grit, shot or wire followed by pickling), or 100 % conditioned.~~

13. Test Methods Bond Quality

~~13.1 The p cladding metal shall be integrally and continuously bonded to the base metal.~~

~~13.2 Inspection:~~

~~13.2.1 Clad plates less than 0.375 in. (9.5 mm) total minimum composite thickness shall be visually inspected for bond integrity prior to shipment.~~

~~13.2.2 Clad plates 0.375 in. (9.5 mm) and thicker total minimum composite thickness shall be ultrasonically inspected for bond integrity prior to shipment in accordance with the procedures and methods of Specification A 578/A 578M.~~

~~13.2.3 Areas of non-bond detected visually in e 13.2.1 shall be explored ultrasonically to determine the extent of disagreement, the condition per 13.2.2. For purposes of defining non-bond, the cladding shall be interpreted to be non-bonded when there is complete loss of back reflection accompanied by an echo indication from the plane of the interface of the clad and backing steel. Areas within 1 in. (25 mm) of a cut edge on the plate that contain indications exceeding 50 % of the back reflection at the bond interface shall be considered to be non-bonded.~~

~~13.2.4 The extent of ultrasonic examination shall be at the discretion of the manufacturer and sufficient to provide the quality level in accordance 13.3 specified by the purchaser. Plates shall be examined with 100 % coverage when Supplementary Requirement S1 is specified.~~

13.3 Quality Levels:

13.3.1 Class A—No single unbonded area exceeding 1 in. (25 mm) in its longest dimension with total unbonded area not to exceed 1 % of the ASTM standards listed total clad surface area.

13.3.2 Class B—No single unbonded area exceeding 3 in. (75 mm) in its longest dimension with total unbonded area not to exceed 3 % of the total clad surface area.

13.3.3 Class C—No single unbonded area exceeding 9 in.² (58 cm²) with total unbonded area not to exceed 5 % of the total clad surface area.

13.3.4 The Class to be supplied shall be listed on the purchase order. When none has been specified, plates shall be furnished as Class C.

14. Significance Rework of Numerical Limits

14.1 For purposes of determining compliance with Cladding by Welding

14.1 The material manufacturer may rework defects in cladding by welding provided the specific limits for following requirements of the properties listed are met:

14.1.1 When specified in the following tabulation, an observed value purchase order, prior approval shall be obtained from the purchaser.

14.1.2 The welding procedure and the welders or calculated value welding operators shall be rounded qualified in accordance with ASME BPV Code Section IX, as applies to overlays.

14.1.3 The defective area shall be removed, and the area prepared for rework shall be examined by a liquid penetrant method compliant with ASME Code Section VIII, Division 1, Appendix 8, to ensure all defective area has been removed.

14.1.4 The rework weld shall be deposited in accordance with Recommended Practice E-29:

<u>Property</u>	<u>Rounded Unit for Observed or Calculated Value</u> <u>Rounded Unit a welding procedure and welding materials suitable for Observed or Calculated Value</u>
<u>Chemical composition</u>	<u>nearest unit in the last right hand place of figure of the specified limit</u>
<u>Chemical composition</u>	<u>nearest unit the cladding material. The surface condition of the reworked area shall be restored to a condition similar to the rest of the cladding.</u>
<u>Tensile strength</u>	<u>transmitted as a part of the specified limit</u> <u>nearest 1 ksi (nearest 5 MPa)</u>

14.1.5 The reworked area shall be examined by a liquid penetrant method in accordance with ASME Code Section VIII, Division 1, Appendix 8.

14.1.6 The location and extent of the weld rework together with the rework procedure and examination results shall be transmitted as a part of the specified limit

certification.

14.2 The material manufacturer may repair defects in the base metal by welding provided repairs are permitted in the base metal specification and are made in accordance with that specification.

15. Inspection

15.1 The manufacturer General Requirements for Delivery

15.1 Material furnished under this specification shall inspect and make the tests necessary conform to verify that the product furnished conforms to the applicable requirements of this specification.

15.2 If, in addition, the purchaser elects to perform a source inspection, current edition of Specification A 6/A 6M or A 20/A 20M as appropriate for the manufacturer shall afford backing metal.

15.2 In the inspector representing the purchaser all reasonable facilities to satisfy him that the product is being furnished in accordance with event of conflicts between this specification. All tests specification and the inspection shall be conducted so as not to interfere unnecessarily with general delivery requirement specification for the operation of the works. backing steel, this specification shall apply.

16. Rejection

16.1 Should the product on receipt at destination be found not to conform to the specification, the product may be rejected and the manufacturer notified after receipt of the material.

17. Certification

17.1 When specified on

16.1 The chemical analysis of the purchase order, base metal and the manufacturer alloy cladding shall furnish be certified to the purchaser a certificate stating that each lot has been sampled, tested, by the clad plate manufacturer.

16.2 The results of the tests in Section 7 and any other tests required by the purchase order shall be reported to the purchaser.

16.3 Compliance with the clad quality level of 13.3 shall be certified. Reports shall include the results of ultrasonic inspection when Supplementary Requirement S.1 is specified.

17. Product Marking

17.1 Except as specified in 17.2, plates shall be marked in accordance with this specification, and has met the requirements of Specification A 6/A 6M or A 20/A 20M for the backing steel as applicable, the cladding alloy designation, and this specification number.

17.2 For double-clad material or for material under 0.375 in. (9.5 mm) nominal in thickness or for clad plates provided with conditioned surfaces, the marking specified in 17.1 shall be legibly stenciled instead of stamped.

18. Mill Test Report

18.1 When specified on the purchase order, the manufacturer shall furnish to the purchaser a test report showing results of the tests required by the specification.

18.2 When material is ordered to ASME Specification, mill test reports are mandatory.

19. Packaging, and Package Marking

19.1 The material shall be separated by size and composition and packed in such a manner as to ensure acceptance by common carrier for transportation and to afford protection from the normal hazards of transportation.

19.2 Except as specified in 19.3, the name or brand of the manufacturer, the manufacturer's test identification number, the class of the base steel, the designation of the cladding metal, and the specified minimum tensile strength shall be legibly marked on each finished single

Keywords
18.1 bond strength; clad; cladding; clad-plate in two places on the base steel side not less than 12 in. (305 mm) from the edges. The manufacturer's test identification number shall be legibly marked on each specimen.

19.3 For double-clad material or for material under plate; copper; copper-base alloy; steel ¼ in. (6.35 mm) in thickness, the marking specified in 19.2 shall be legibly stenciled instead of stamped.

19.4 Each shipping unit shall be legibly marked with the purchase order number, metal or alloy description, temper, size, shape, gross and net weight, and name of supplier. The specification number shall be shown, when specified.

SUPPLEMENTARY REQUIREMENTS

S1.1 The clad steel

Supplementary requirements shall not apply unless specified on the order.

S1. Ultrasonic Inspection of 100 % of Surface

S1.1 Ultrasonic inspection shall be performed with scanning over 100 % of the plate surface.

S2. Product Analysis

S2.1 A product analysis shall be ultrasonically tested for bond integrity. Unless otherwise specified, made on either the bond parameters cladding metal, base metal, or both as specified in the purchase order.

S2.2 Testing shall be in accordance with Section 10 unless Section S2.4 applies.

S2.3 The testing frequency shall be agreed upon between purchaser and manufacturer.

S2.4 Product verification by Positive Metal Identification (PMI) techniques may be used as follows:

S1.2 ~~Tube Sheets~~ Bond area an alternate to the requirements of Section 10 when mutually agreed upon.

S3. Simulated Post-Weld Heat Treatment of Mechanical Test Coupons

S3.1 Prior to testing, the test specimens representing the plate for acceptance purposes for mechanical properties shall be at least 98 % thermally treated to simulate a post-weld heat treatment, using the heat treatment parameters (such as temperature range, time, and cooling rates) specified in the order. The test results for such heat-treated test specimens shall meet the applicable product specification requirements.

S4. Charpy V-Notch Impact Test

S4.1 Charpy V-notch impact tests shall be conducted in accordance with Supplementary Requirement S5 of A 6 or A 20, as applicable for the base metal specification.

S5. Ultrasonic Examination of Base Metal for Soundness in Accordance with individual non-bond areas not exceeding 1 in.².

~~S1.3 Other Applications—Bond area Specification A 578/A 578M~~

~~S5.1 All plates shall be at least 95% ultrasonically examined for base metal soundness in accordance with the requirements of A 578/A 578M. The acceptance level shall be specified in the total interface areas with individual nonbond areas not exceeding 4 in.² order.~~

APPENDIX

(Nonmandatory Information)

X1. METRIC EQUIVALENTS

X1.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI). The derived SI unit for force is the newton (N), which is defined as that force which, when applied to a body having a mass of one kilogram, gives it an acceleration of one metre per second squared ($N = \text{kg}\cdot\text{m}/\text{s}^2$). The derived SI unit for pressure or stress is the newton per square metre (N/m^2) which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since 1 ksi = 6 894 757 Pa, the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m^2 and N/mm^2 .

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B 432 – 91 (1998)) that may impact the use of this standard. (Approved May 1, 2004.)

- (1) Revised Scope, Referenced Documents, and Terminology sections.
- (2) Added mandatory ultrasonic testing requirements.
- (3) Added an alternative bond strength test (bend test).
- (4) Added weld rework criteria.
- (5) Added product analysis criteria.
- (6) Deleted the flatness table for plates, defaulting to the applicable steel flatness tables.
- (7) Deleted unique test specimens, defaulting to the applicable steel tests.
- (8) Deleted other unnecessary or obsolete sections.

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