and similar parts. Rod and bar materials shall conform to the requirements for bars or bolting in the applicable Part of Subsection C.

(b) Parts Machined From Rod and Bar. Pressure parts such as hollow cylindrically shaped parts, heads, caps, flanges, elbows, return bends, tees, and header tees may be machined directly from rod or bar as provided in (1) through (4) below.

(1) Examination by the magnetic particle or liquid penetrant method in accordance with the requirements of Mandatory Appendix 6 or Mandatory Appendix 8 respectively, shall be as follows:

(-a) for flanges: the back of the flange and the outer surface of the hub

(-b) for heads, caps, elbows, return bends, tees, and header tees: all surfaces

(-c) for hollow, cylindrically shaped parts: no surface examination needed

(2) Parts may be machined from rod or bar having a hot-worked diameter not greater than 5.50 in. (140 mm), provided that the axial length of the part is approximately parallel to the metal flow lines of the stock.

(3) Parts may be machined from rod or bar having a hot-worked diameter greater than 5.50 in. (140 mm), but not greater than 8.00 in. (205 mm), provided the axial length of the part is approximately parallel to the metal flow lines of the stock, and the minimum required thickness of the component is calculated following the rules of this Division using 50% of the specified allowable stress.

(4) As an alternative to (3) above and for rod or bar having a hot-worked diameter greater than 8.00 in. (205 mm), parts may be machined from such rod or bar, if the following requirements are met:

(-a) The longitudinal axis of the part shall be parallel to the longitudinal axis of the rod or bar.

(-b) At least two transverse tension test specimens shall be taken from each lot (as defined in the material specification) of rod or bar material. The rods or bars within each lot shall be of the same diameter.

(-1) The second specimen shall be taken at 90 deg around the perimeter from the first specimen.

(-2) The axis of the tension test specimen shall be located, as nearly as practicable, midway between the center thickness and the surface of the rod or bar.

(-3) Both specimens shall meet the mechanical property requirements of the material specification.

(-4) For Table UCS-23 materials, the reduction of area shall be not less than 30%.

(-c) Each rod or bar, before machining, shall be 100% ultrasonically examined perpendicular to the longitudinal axis by the straight beam technique in accordance with SA-388. The rod or bar shall be unacceptable if either of the following occurs:

(-1) The examination results show one or more indications accompanied by loss of back reflection larger than 60% of the reference back reflection.

(-2) The examination results show indications larger than 40% of the reference back reflection when accompanied by a 40% loss of back reflection.

(-d) For heads and the flat portion of caps, the examinations of (-c) shall also be performed in the axial direction.

(-e) Before welding, the cut surfaces of the part adjacent to the weld shall be examined by magnetic particle or liquid penetrant methods in accordance with Mandatory Appendix 6 or Mandatory Appendix 8, respectively.

UG-15 PRODUCT SPECIFICATION

When there is no material specification listed in Subsection C covering a particular wrought product of a grade, but there is an approved specification listed in Subsection C covering some other wrought product of that grade, the product for which there is no specification may be used provided:

(a) the chemical and physical properties, heat treating requirements, and requirements for deoxidation, or grain size requirements conform to the approved specification listed in Subsection C. The stress values for that specification given in the tables referenced in UG-23 shall be used.

(b) the manufacturing procedures, tolerances, tests, and marking are in accordance with a Section II specification covering the same product form of a similar material;

(c) for the case of welded tubing made of plate, sheet, or strip, without the addition of filler metal, the appropriate stress values are multiplied by a factor of 0.85;

(d) the product is not pipe or tubing fabricated by fusion welding with the addition of filler metal unless it is fabricated in accordance with the rules of this Division as a pressure part;

(e) mill test reports reference the specifications used in producing the material and in addition make reference to this paragraph.

DESIGN

UG-16 GENERAL

add a period "." at the end of the sentence.

(a) The design of pressure vessels and vessel parts shall conform to the general design requirements in the following paragraphs and in addition to the specific requirements for *Design* given in the applicable Parts of Subsections B and C As an alternative, the design rules of Mandatory Appendix 46 may be used.

(b) Minimum Thickness of Pressure-Retaining Components. Except for the special provisions listed below, the minimum thickness permitted for shells and heads, after forming and regardless of product form and material, shall be $^{1}/_{16}$ in. (1.5 mm) exclusive of any corrosion allowance. Exceptions are:

(1) the minimum thickness does not apply to heat transfer plates of plate-type heat exchangers;

Errata

Table UHX-1.1
Paragraph Cross-Reference List

Topic	Division 2
Scope	4.18.1
Terminology	4.18.2
Design	4.18.3
Tubesheet design definitions	4.18.15
Tubesheet effective bolt load, *W**	Table 4.18.6
Tubesheet extension	4.18.5
General conditions of applicability for tubesheets	4.18.4
Tubesheet characteristics	4.18.6
Rules for the design of U-tube tubesheets	4.18.7
Rules for the design of fixed tubesheets	4.18.8
Rules for the design of floating tubesheets	4.18.9
Bellows expansion joints	4.18.11 [Note (1)]
Flexible shell elements expansion joints	4.18.12 [Note (2)]

NOTES:
(1) The first sentence of 4.18.11 refers to 4.19. Per Table UHX-1.2, use Mandatory Appendix 26. The balance of 4.18.11 applies.
(2) Paragraph 4.18.12(a) refers to 4.20. Per Table UHX-1.2, use Mandatory Appendix 5. The balance of 4.18.12 applies.

UHX-19.2 Supplemental Marking

A supplemental tag or marking shall be supplied on the heat exchanger to caution the user if there are any restrictions on the design, testing, or operation of the heat exchanger. The marking shall meet the requirements of UG-118 or UG-119, except that height of the characters for the caution required by UHX-19.2.2 shall be at least $^1/_8$ in. (3 mm) high. Supplemental marking shall be required for, but not limited to, the following:

UHX-19.2.1 Common Elements. Shell-and-tube heat exchangers are combination units as defined in UG-19(a) and the tubes and tubesheets are common elements. The following marking is required when the common elements are designed for conditions less severe than the design conditions for which its adjacent chambers are stamped.

(a) Differential Pressure Design. When common elements such as tubes and tubesheets are designed for a differential design pressure, the heat exchanger shall be marked "Differential Design" in addition to meeting all the requirements of UG-19(a)(2) [see UG-116(j)]. If the tubes and tubesheets are designed for a differential pressure of 150 psi, an example of the marking would be

DIFFERENTIAL DESIGN: TUBES
& TUBESHEETS 150 psi

Table UHX-1.2
Reference Paragraph Cross-Reference List

Topic	Division 2	Division 1 – 2021 Edition
Jacketed vessels	4.11	Mandatory Appendix 9
Bolted flange connections	4.16	Mandatory Appendix 2
Bellows expansion joints	4.19	Mandatory Appendix 26
Flexible shell element expansion joints	~~4.2~~ 4.20	Mandatory Appendix 5
Tube-to-tubesheet joint strength	4.21	UW-20
Cone-to-cylinder junction under internal pressure	4.3.11, 4.3.12	1-5 [see UHX-1(a)(5)(-a)]
Cone-to-cylinder junction under external pressure	4.4.13, 4.4.14	1-8 [see UHX-1(a)(5)(-b)]
Flanges and pipe fittings	4.1.11	UG-44(a)
Tubesheets without a bolting flange	Table 4.2.6	Figure UW-13.2, sketches (a) through (g)
Tubesheets with a bolting flange	Table 4.2.8	Figure UW-13.2, sketches (h) through (l)
Tubesheets with butt weld hubs	Table 4.2.7	Figure UW-13.3
Allowable compressive stress	4.4.12.2 [Note (1)]	UG-23(b)

NOTE:
(1) Required by 46-2(a)(1).

Table UHX-1.1 Paragraph Cross Reference List	
Topic	**Division 2**
Scope	4.18.1
Terminology	4.18.2
Design	4.18.3
Tubesheet Design Definitions	4.18.15
Tubesheet Effective Bolt Load, *W**	Table 4.18.6
Tubesheet Extension	4.18.5
General Conditions of Applicability for Tubesheets	4.18.4
Tubesheet Characteristics	4.18.6
Rules for the Design of U-Tube Tubesheets	4.18.7
Rules for the Design of Fixed Tubesheets	4.18.8
Rules for the Design of Floating Tubesheets	4.18.9
Bellows Expansion Joints	4.18.11 (See Note 1)
Flexible Shell Elements Expansion Joints	4.18.12 (See Note 2)

Notes: 1. The first sentence of 4.18.11 refers to 4.19. Per Table UHX-1.2 use Appendix 26. The balance of 4.18.11 applies.
2. 4.18.12(a) refers to 4.20. Per Table UHX-1.2, use Appendix 5. The balance of 4.18.12 applies.

Table UHX-1.2 Reference Paragraph Cross Reference List		
Topic	**Division 2**	**Division 1 – 2021 Edition**
Jacketed Vessels	4.11	Appendix 9
Bolted Flange Connections	4.16	Appendix 2
Bellows Expansion Joints	4.19	Appendix 26
Flexible Shell Element Expansion Joints	4.20	Appendix 5
Tube-to-Tubesheet Joint Strength	4.21	UW-20
Cone-to-Cylinder Junction under Internal Pressure	4.3.11, 4.3.12	1-5 (See UHX-1(a)(5)(-a)
Cone-to-Cylinder Junction under External Pressure	4.4.13, 4.4.14	1-8 (See UHX-1(a)(5)(-b)
Flanges and Pipe Fittings	4.1.11	UG-44(a)
Tubesheets Without a Bolting Flange	Table 4.2.6	Figure UW-13.2, sketches (a) thru (g)
Tubesheets With a Bolting Flange	Table 4.2.8	Figure UW-13.2, sketches (h) thru (l)
Tubesheets With Butt Weld Hubs	Table 4.2.7	Figure UW-13.3
Allowable Compressive Stress	4.4.12.2 (See Note 1)	UG-23(b)

Note 1. Required by 46-2(a)(1).