

Title:	API 650 Annex S, addition of UNS S31655		Agenda Item # 650-2085
Date:	5/7/2026		
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Purpose:	Addition of duplex stainless steel UNS S31655 to relevant paragraphs of API 650 Annex S.		
Source:	C. Tigerstrand, RATIONALE AND SUPPORTING DATA FOR INCLUSION OF AUSTENITIC STAINLESS STEEL UNS S31655 (316plus) IN API 650 AND API 620 ANNEX S.		
Revision:	Rev. 2 in Red. Original API 650 Text in Black.		
Impact:	Alloy no and specifications to be included in the text of paragraphs: S.1.1 and S.4.4.3. Alloy no and values to be included in tables: S.1a, S.1b, S.2a, S.2b, S.3a, S.3b, S.5a and S.5b.		
Rationale:	The nitrogen alloyed austenitic stainless steel S31655 is developed using a leaner alloying concept than regular 316L and 316LN. Despite its leaner chemistry it provides similar (or higher) corrosion resistance compared to type 316 in most environments. The relatively high nitrogen content gives higher mechanical strength than 316L. This grade can potentially provide more cost-effective solutions than 316L, particularly for larger tanks, where its higher strength can be fully utilized.		
Current Document:	API 650 14th Edition, Annex S.		
Proposed Document:	S.1.1 This Annex covers materials, design, fabrication, erection, and testing requirements for vertical, cylindrical, aboveground, closed- and open-top, welded, austenitic stainless steel storage tanks constructed of material grades 201-1, 201LN, 304, 304L, 316, 316L, S31655, 317, and 317L. This Annex does not cover stainless steel clad plate or strip lined construction. S.4.4.3 Warm forming at 540 °C (1000 °F) to 650 °C (1200 °F) may cause intergranular carbide precipitation in 304, 316, and 317 grades of stainless steel. Unless stainless steel in this sensitized condition is acceptable for the service of the equipment, it will be necessary		

to use 304L, 316L, **S31655** or 317L grades or to solution anneal and quench after forming. Warm forming shall be performed only with agreement of the Purchaser.

Table S.1a

Table S.1a—ASTM Materials for Stainless Steel Components (SI)

Plates and Structural Members (Note 1)	Piping and Tubing—Seamless or Welded (Note 2)	Forgings (Notes 2, 3)	Bolting and Bars (Notes 4, 5)
A240M , Type 201-1	A213M , Grade TP 201	A182M , Grade F 304	A193M , Class 1, Grades B8, B8A, and B8M
A240M , Type 201LN	A213M , Grade TP 304	A182M , Grade F 304L	A194M , Grades B8, B8A, B8M, and B8MA
A240M , Type 304	A213M , Grade TP 304L	A182M , Grade F 316	A320M , Grades B8, B8A, B8M, and B8MA
A240M , Type 304L	A213M , Grade TP 316	A182M , Grade F 316L	A276, A479M, Type 304
A240M , Type 316	A213M , Grade TP 316L	A182M , Grade F 317	A276 , A479M , Type 304L
A240M , Type 316L	A213M , Grade TP 317	A182M , Grade F 317L	A276, A479M, Type 316
A240M , Type 317	A213M , Grade TP 317L		A276 , A479M , Type 316L
A240M , Type 317L	A312M , Grade TP 304		A276 , A479M , Type 317
A240M S31655	A312M , Grade TP 304L		
	A312M , Grade TP 316		
	A312M , Grade TP 316L		
	A312M , Grade TP 317		
	A312M , Grade TP 317L		
	A358M , Grade 304		
	A358M , Grade 304L		
	A358M , Grade 316		
	A358M , Grade 316L		
	A403M , Class WP 304		
	A403M , Class WP 304L		
	A403M , Class WP 316		
	A403M , Class WP 316L		
	A403M , Class WP 317		
	A403M , Class WP 317L		
	A312M S31655		
	A358M S31655		

- NOTE 1 Unless otherwise specified by the Purchaser, plate, sheet, or strip shall be furnished with a No. 1 finish. Plate shall be either hot-rolled or cold-rolled, annealed, and descaled. Sheet shall be hot-rolled, annealed, and descaled. Strip shall be cold-rolled, annealed, and descaled.
- NOTE 2 Carbon steel flanges and/or stub ends may be used by agreement between the Purchaser and the Manufacturer, providing the design and details consider the dissimilar properties of the materials used and are suitable for the intended service.
- NOTE 3 Castings shall not be used unless specified by the Purchaser. If specified, castings shall meet [ASTMA351](#) and shall be inspected in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Annex 7.
- NOTE 4 All bars in contact with the product shall be furnished in the hot-rolled, annealed, and descaled condition.
- NOTE 5 Other bolting materials may be used by agreement between the Purchaser and the Manufacturer.

Table S.1b

Table S.1b—ASTM Materials for Stainless Steel Components (USC)

Plates and Structural Members (Note 1)	Piping and Tubing—Seamless or Welded (Note 2)	Forgings (Notes 2, 3)	Bolting and Bars (Notes 4, 5)
A240, Type 201-1	A213, Grade TP 201	A182, Grade F 304	A193, Class 1, Grades B8, B8A, and B8M
A240, Type 201LN	A213, Grade TP 304	A182, Grade F 304L	A194, Grades 8, 8A, 8M, and 8MA
A240, Type 304	A213, Grade TP 304L	A182, Grade F 316	A320, Grades B8, B8A, B8M, and B8MA
A240, Type 304L	A213, Grade TP 316	A182, Grade F 316L	A276, A479, Type 304
A240, Type 316	A213, Grade TP 316L	A182, Grade F 317	A276, A479, Type 304L
A240, Type 316L	A213, Grade TP 317	A182, Grade F 317L	A276, A479, Type 316
A240, Type 317	A213, Grade TP 317L		A276, A479, Type 316L
A240, Type 317L	A312, Grade TP 304		A276, A479, Type 317
A276, Type 201	A312, Grade TP 304L		
A276, Type 304	A312, Grade TP 316		
A276, Type 304L	A312, Grade TP 316L		
A276, Type 316	A312, Grade TP 317		
A276, Type 316L	A312, Grade TP 317L		
A276, Type 317	A358, Grade 304		
A240 S31655	A358, Grade 304L		
	A358, Grade 316		
	A358, Grade 316L		
	A403, Class WP 304		
	A403, Class WP 304L		
	A403, Class WP 316		
	A403, Class WP 316L		
	A403, Class WP 317		
	A403, Class WP 317L		
	A312 S31655		
	A358 S31655 L		

- NOTE 1 Unless otherwise specified by the Purchaser, plate, sheet, or strip shall be furnished with a No. 1 finish. Plate shall be either hot-rolled or cold-rolled, annealed, and descaled. Sheet shall be hot-rolled, annealed, and descaled. Strip shall be cold-rolled, annealed, and descaled.
- NOTE 2 Carbon steel flanges and/or stub ends may be used by agreement between the Purchaser and the Manufacturer, providing the design and details consider the dissimilar properties of the materials used and are suitable for the intended service.
- NOTE 3 Castings shall not be used unless specified by the Purchaser. If specified, castings shall meet ASTM A351 and shall be inspected in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Annex 7.
- NOTE 4 All bars in contact with the product shall be furnished in the hot-rolled, annealed, and descaled condition.
- NOTE 5 Other bolting materials may be used by agreement between the Purchaser and the Manufacturer.

Table S.2a

Table S.2a—Allowable Stresses for Tank Shells (SI)

Type	Min. Yield MPa	Min. Tensile MPa	Allowable Stress (S_d) (in MPa) for Maximum Design Temperature Not Exceeding					
			40 °C	90 °C	150 °C	200 °C	260 °C	S_d Ambient
201-1	260	515	155	136	125	121	—	234
201LN	310	655	197	172	153	145	143	279
304	205	515	155	155	140	128	121	186
304L	170	485	145	132	119	109	101	155
316	205	515	155	155	145	133	123	186
316L	170	485	145	131	117	107	99	155
317	205	515	155	155	145	133	123	186
317L	205	515	155	155	145	133	123	186
S31655	310	635	191	187	176	169	163	279

NOTE 1 S_d may be interpolated between temperatures.

NOTE 2 The design stress shall be the lesser of 0.3 of the minimum tensile strength or 0.9 of the minimum yield strength. The factor of 0.9 of yield corresponds to a permanent strain of 0.10 %. When a lower level of permanent strain is desired, the Purchaser shall specify a reduced yield factor in accordance with Table Y-2 of ASME Section II, Part D. The yield values at the different maximum design temperatures can be obtained from Table S.5a.

NOTE 3 For dual-certified materials (e.g. ASTM A182M/A182 Type 304L/304), use the allowable stress of the grade specified by the Purchaser.

Table S.2b

Table S.2b—Allowable Stresses for Tank Shells (USC)

Type	Min. Yield psi	Min. Tensile psi	Allowable Stress (S_d) (in psi) for Maximum Design Temperature Not Exceeding					
			100 °F	200 °F	300 °F	400 °F	500 °F	S_d Ambient
201-1	38,000	75,000	22,500	19,700	18,100	17,500	—	34,200
201LN	45,000	95,000	28,500	24,900	22,200	21,100	20,700	40,500
304	30,000	75,000	22,500	22,500	20,300	18,600	17,500	27,000
304L	25,000	70,000	21,000	19,200	17,200	15,800	14,700	22,500
316	30,000	75,000	22,500	22,500	21,000	19,300	17,900	27,000
316L	25,000	70,000	21,000	19,000	17,000	15,500	14,300	22,500
317	30,000	75,000	22,500	22,500	21,000	19,300	17,900	27,000
317	30,000	75,000	22,500	22,500	21,000	19,300	17,900	27,000
S31655	45,000	92,000	27,600	27,200	25,500	24,400	23,600	40,500

NOTE 1 S_d may be interpolated between temperatures.

NOTE 2 The design stress shall be the lesser of 0.3 of the minimum tensile strength or 0.9 of the minimum yield strength. The factor of 0.9 of yield corresponds to a permanent strain of 0.10 %. When a lower level of permanent strain is desired, the Purchaser shall specify a reduced yield factor in accordance with Table Y-2 of ASME [Section II, Part D](#). The yield values at the different maximum design temperatures can be obtained from Table S.5b.

NOTE 3 For dual-certified materials (e.g. ASTM A182M/A182 Type 304L/304), use the allowable stress of the grade specified by the Purchaser.

Table S.3a

Table S.3a—Allowable Stresses for Plate Ring Flanges (SI)

Type	Allowable Stress (S_a) (in MPa) for Maximum Design Temperature Not Exceeding				
	40 °C	90 °C	150 °C	200 °C	260 °C
201-1	155	133	115	104	--
201LN	197	167	151	143	138
304	140	115	103	95	89
304L	117	99	88	81	75
316	140	119	107	99	92
316L	117	97	87	79	73
317	140	119	108	99	92
317L	140	119	108	99	92
S31655	190	167	145	134	126
NOTE 1 Allowable stresses may be interpolated between temperatures. NOTE 2 The allowable stresses are based on a lower level of permanent strain. NOTE 3 The design stress shall be the lesser of 0.3 of the minimum tensile strength or $\frac{2}{3}$ of the minimum yield strength. • NOTE 4 For dual-certified materials (e.g. ASTM A182M/A182 Type 304L/304), use the allowable stress of the grade specified by the Purchaser.					

Table S.3b

Table S.3b—Allowable Stresses for Plate Ring Flanges (USC)

Type	Allowable Stress (S_a) (in psi) for Maximum Design Temperature Not Exceeding				
	100 °F	200 °F	300 °F	400 °F	500 °F
201-1	22,500	19,300	16,700	15,100	--
201LN	28,500	24,200	21,900	20,700	20,000
304	20,000	16,700	15,000	13,800	12,900
304L	16,700	14,300	12,800	11,700	10,900
316	20,000	17,200	15,500	14,300	13,300
316L	16,700	14,100	12,600	11,500	10,600
317	20,000	17,300	15,600	14,300	13,300
317L	20,000	17,300	15,600	14,300	13,300
S31655	27,600	23,900	21,100	19,300	18,200
NOTE 1 Allowable stresses may be interpolated between temperatures. NOTE 2 The allowable stresses are based on a lower level of permanent strain. NOTE 3 The design stress shall be the lesser of 0.3 of the minimum tensile strength or $\frac{2}{3}$ of the minimum yield strength. • NOTE 4 For dual-certified materials (e.g. ASTM A182M/A182 Type 304L/304), use the allowable stress of the grade specified by the Purchaser.					

Table S.5a

Table S.5a—Yield Strength Values in MPa (SI)

Type	Yield Strength (in MPa) for Maximum Design Temperature Not Exceeding				
	40 °C	90 °C	150 °C	200 °C	260 °C
201-1	260	199	172	157	—
201LN	310	250	227	214	207
304	205	170	155	143	134
304L	170	148	132	121	113
316	205	178	161	148	137
316L	170	145	130	119	110
317	205	179	161	148	138
317L	205	179	161	148	138
S31655	310	250	218	201	188
NOTE 1 Interpolate between temperatures.					
NOTE 2 Reference: Table Y-1 of ASME Section II , Part D.					

Table S.5b

Table S.5b—Yield Strength Values in psi (USC)

Type	Yield Strength (in psi) for Maximum Design Temperature Not Exceeding				
	100 °F	200 °F	300 °F	400 °F	500 °F
201-1	38,000	28,900	25,000	22,700	—
201LN	45,000	36,300	32,900	31,100	30,000
304	30,000	25,000	22,500	20,700	19,400
304L	25,000	21,400	19,200	17,500	16,400
316	30,000	25,800	23,300	21,400	19,900
316L	25,000	21,100	18,900	17,200	15,900
317	30,000	25,900	23,400	21,400	20,000
317L	30,000	25,900	23,400	21,400	20,000
S31655	45,000	35,900	31,700	29,000	27,300
NOTE 1 Interpolate between temperatures.					
NOTE 2 Reference: Table Y-1 of ASME Section II , Part D.					