

API Ballot id # 5827 SC5 TGDSE

Work Item	7056 – Add Hardness Requirements for SS Grades
Type of Distribution [Ballot (vote and comment), Comment-only, Recirculation (comment resolution), Re-ballot, etc.]	Ballot 2 (voting and commenting on updates per Ballot 1 id # 5664)
Impacted Document	SPEC 5DP, 2 nd Edition
Other Impacts	None
Revision Key	<p>Current/unchanged content in BLACK; Track Changes as:</p> <ol style="list-style-type: none"> 1) <u>Additions in underlined BLUE</u> 2) Deletions in stricken RED 3) Changes accepted from Ballot 1 in highlighted GRAY <p>NOTE The “*****” indicates there is un-altered content above/below.</p>

Work Item Charge: To add hardness requirements for SS grades of drill pipe.

Ballot Rationale: SS grades were added in 2nd Edition. Hardness requirements were included for the weld zone, but not for pipe body or tool joint. The IRP has both, so 5DP has not included all elements of this standard. This ballot is for an addendum to make 5DP pipe fully compliant with IRP, by adding hardness testing requirements and increased impact toughness.

Special Note—Figure B.16 will be improved upon for better clarity and available as part of comment resolution.

NOTE See the ballot email notification for additional information regarding this ballot.

Drill Pipe

API SPECIFICATION 5DP
SECOND EDITION, MAY 2020

ERRATA 1, JULY 2020

API MONOGRAM PROGRAM EFFECTIVE DATE: NOVEMBER 1, 2020

ADDENDUM 1, JANUARY 2021
(API MONOGRAM PROGRAM EFFECTIVE DATE: JULY 1, 2021)

1 Scope

1.1 Coverage

NOTE 4 See ISO 15156 / NACE MR0175 for the use of drilling equipment in H₂S-containing fluids, including permitted exclusions to its scope.

6 Requirements for Drill Pipe

6.3 Material Requirements

6.3.3 Weld Zone Hardness

For surface hardness, no hardness number shall exceed 37 HRC, or equivalent, for Grades E, X, G and S, or 40 HRC for Grade V. For SS grades, the surface hardness shall not exceed 32 HRC.

For the through-wall hardness test, the mean hardness number of the weld zone shall not exceed 37 HRC, or equivalent, for Grades E, X, G and S, or 40 HRC for Grade V. For SS grades, the mean hardness of the weld zone shall not exceed the values in Table C.18 or Table D.18.

7 Requirements for Drill Pipe Body

7.2 Material Requirements

7.2.1 Chemical Composition and Microstructure

The chemical composition shall be as provided in Table C.4 or Table D.4.

In addition, the pipe body for grades SS95 and SS105 shall contain 0.35 % maximum C, 1.00 % maximum Mn, 0.90–1.30 % Cr and 0.30–0.60 % Mo, unless otherwise agreed by the purchaser. All SS grades shall have grain size of 6 or finer in accordance with ASTM E112, and shall have transformed to martensite after quenching over at least 90 % of the pipe wall.

7.2.7 Hardness Testing of Pipe Body

Hardness testing of the pipe body for SS grades shall be carried out on a radial cross-section taken at least one radius away from the end of the upset, using the same procedures for tool joints as in G.3.

7.2.7.8 Drill Pipe Body Hardness for SS Grades

Surface hardness shall be reported on every joint of drill pipe body for SS grades. ~~Selection of the hardness testing method is at the manufacturer's option, including the use of an alternative test method. In such cases, the manufacturer shall demonstrate the equivalence to 6.9.4~~ Test methods are described in 6.9.

A through-wall hardness survey using the procedure of G.3 shall be made for every ~~heat per heat treat lot, and every 200 tubes for larger from every~~ heat treat lots.

The hardness shall not exceed the limits of Table C.18 or Table D.18.

8 Requirements for Tool Joints

8.2 Material Requirements

8.2.1 Chemical Composition and Microstructure

The chemical composition shall be as provided in Table C.4 or Table D.4.

In addition, tool joints for grades SS90 and SS105 shall contain 0.35 % maximum C, 1.00 % maximum Mn, 0.70–1.30 % Cr and 0.40–0.70 % Mo, unless otherwise agreed by the purchaser. All SS grades shall have grain size of 6 or finer in accordance with ASTM E112, and shall have transformed to martensite after quenching over at least 90 % of the full wall.

8.2.3 Hardness of Tool Joints

For non-SS grades, the hardness for the tool joint box shall be in the range 285 HBW to 341 HBW; ~~except for SS grades.~~ For SS grades, the surface hardness for both box and pin tool joints shall be in the range 247 HBW to 301 HBW. ~~Selection of the hardness testing method is at the manufacturer's option, including the use of an alternative test method. In such cases, the manufacturer shall demonstrate equivalence to 6.9.1~~ Test methods are described in 6.9.

For tool joints of SS grades, hardness testing shall be done at three sections: (1) in the weld neck (at least one wall thickness away from the end), (2) in the connection area (at least one wall thickness away from the end), and (3) at the thickest point (the tong section). Alternatively, the testing shall be a single radial cross-section plus a longitudinal section, with hardness test near inside surface, outside surface and mid wall, at axial intervals not to exceed 1 inch, as shown in Figure B.16.

The hardness shall ~~comply with~~ not exceed the limits of Table C.18 or Table D.18. This requirement shall not apply to the through-wall hardness variation requirements in G.3; except that for SS grades, Table C.18 or Table D.18 maximum limits shall apply.

Additional requirements for PSL-3 and SS grades are in Annex G. Requirements for SR 25 on high strength tool joints are in Annex E (see E.8).

8.8 Hardness Tests

8.8.3 Frequency of Testing

The hardness test frequency for the box tool joint for non-SS grades, and both box and pin tool joints on SS grades, shall be as in Table C.10 or Table D.10.

When hardness testing is required for pin tool joints due to insufficient material for tensile testing, the hardness testing of the pin tool joint shall be performed at the tensile testing frequency in Table C.10 or Table D.10.

Annex B—Figures in SI (USC) Units

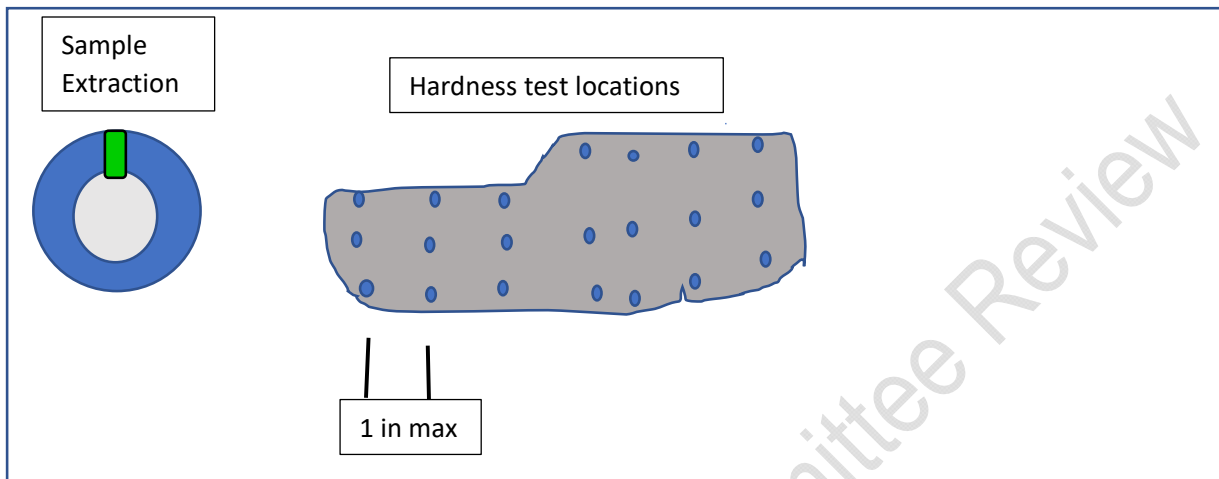


Figure B.16—Longitudinal Hardness Traverse

Annex C [Annex D]—Tables in USC Units [Tables in SI Units]

Table C.8—Charpy V-notch Longitudinal Absorbed Energy Requirements

Product Element	Minimum Average Absorbed Energy ft-lb			Minimum Specimen Absorbed Energy ^a ft-lb		
	Specimen Size, mm × mm			Specimen Size, mm × mm		
	10 × 10	10 × 7.5	10 × 5	10 × 10	10 × 7.5	10 × 5
PSL-1—Test Temperature: 70 °F ±5 °F						
Drill pipe body: grades X, G, S, V	40	32	22	35	28	19
Drill pipe body: grade SS75	—	—	—	50	40	28
Drill pipe body: grades SS95, SS105	—	—	—	60	48	33
Tool joint grades E, X, G, S, V	40	32	22	35	28	19
Tool joint grades SS75, SS95, SS105	66	53	36 37	60	48	33
Weld zone: SS75, SS95, SS105	20	16	12	20	16	12
Weld zone: grades E, X, G, S, V	12	10	—	10	8	—
SR 19 (E.4)—Test Temperature: 70 °F ±5 °F						
Drill pipe body: grade E	40	32	22	35	28	19
SR 20 (E.5)—Test Temperature: 14 °F ±5 °F						
Drill pipe body	30	24	20	22	18	15
Tool joint	30	24	20	22	18	15
Weld zone	12	10	—	10	8	—
SR 24 (E.7)—Test Temperature: 70 °F ±5 °F						
Weld zone	20	16	—	17	14	—
SR 25 (E.8)—Test Temperature: −4 °F ±5 °F						
Tool joint	35	28	23	24	20	16
PSL-3—Test Temperature: −4 °F ±5 °F						
Drill pipe body: all grades except V	74	59	41	59	47	32
Drill pipe body grade V	40	32	22	35	28	19
Tool joint (box and pin)	40	32	22	35	28	19
Weld zone	31	25	—	24	19	—

^a The percent shear area shall be measured and reported for information only.

Table D.8—Charpy V-notch Longitudinal Absorbed Energy Requirements

Product Element	Minimum Average Absorbed Energy J			Minimum Specimen Absorbed Energy ^a J		
	Specimen Size mm × mm			Specimen Size mm × mm		
	10 × 10	10 × 7.5	10 × 5	10 × 10	10 × 7.5	10 × 5
PSL-1—Test Temperature: 21 °C ±3 °C						
Drill pipe body: grades X, G, S, V	54	43	30	47	38	26
Drill pipe body: grade SS75	—	—	—	68	54	38
Drill pipe body: grades SS95, SS105	—	—	—	81	65	45
Tool joint grades E, X, G, S, V	54	43	30	47	38	26
Tool joint grades SS75, SS95, SS105	90	72	50	81	65	45
Weld zone: SS75, SS95, SS105	27	22	16	27	22	16
Weld zone: grades E, X, G, S, V	16	14	—	14	11	—
SR 19 (E.4)—Test Temperature: 21 °C ±3 °C						
Drill pipe body: grade E	54	43	30	47	38	26
SR 20 (E.5)—Test Temperature: –10 °C ±3 °C						
Drill pipe body	41	33	27	30	24	20
Tool joint (box and pin)	41	33	27	30	24	20
Weld zone	16	14	—	14	11	—
SR 24 (E.7)—Test Temperature: 21 °C ±3 °C						
Weld zone	27	22	—	23	19	—
SR 25 (E.8)—Test Temperature: –20 °C ±3 °C						
Tool joint (box and pin)	47	38	32	32	26	22
PSL-3—Test Temperature –20 °C ±3 °C						
Drill pipe body: all grades except V	100	80	56	80	64	43
Drill pipe body grade V	54	43	30	47	38	26
Tool joint (box and pin)	54	43	30	47	38	26
Weld zone	42	34	—	32	26	—
^a The percent shear area shall be measured and reported for information only.						

Tables C.10 / D.10—Test Frequency

	Chemical Analysis	Tensile Test	Charpy Impact Test	Outside Surface Hardness Test	Through-wall Hardness Test	Side-bend Test
Drill Pipe Body—Grade E—PSL-1						
< Label 1: 6-5/8	2 product per heat	1 per 400 or per lot ^a	—	—	—	—
≥ Label 1: 6-5/8	2 product per heat	1 per 200 or per lot ^a	—	—	—	—
Drill Pipe Body—Grade E—SR 19 (E.4)						
< Label 1: 6-5/8	—	—	1 per 400 or per lot ^a	—	—	—
≥ Label 1: 6-5/8	—	—	1 per 200 or per lot ^a	—	—	—
Drill Pipe Body—Grades X, G, S, and V—PSL-1						
< Label 1: 6-5/8	2 product per heat	1 per 200 or per lot ^a	1 per 200 or per lot ^a	—	—	—
≥ Label 1: 6-5/8	2 product per heat	1 per 100 or per lot ^a	1 per 100 or per lot ^a	—	—	—
Drill Pipe Body—SS Grades—PSL-1						
< Label 1: 6-5/8	2 product per heat	1 per 200 or per lot ^a	1 per 200 or per lot ^a	Each pipe	1 per 200 or per lot ^d	—
≥ Label 1: 6-5/8	2 product per heat	1 per 100 or per lot ^a	1 per 100 or per lot ^a	Each pipe	1 per 200 or per lot ^d	—
Tool Joints—PSL-1						
Pin	1 per heat (solid form)	1 per 200 or per lot ^a	1 per 200 or per lot ^a	—	1 per 200 or per lot ^b	—
Box	1 per heat (solid form)	—	1 per 200 or per lot ^a	—	1 per 200 or per lot ^a	—
Tool Joints—PSL-3 and SS Grades						
Pin	1 per heat (solid form)	1 per 200 or per lot ^a	1 per 200 or per lot ^a	Each pin	1 per 200 or per lot ^d	—
Box	1 per heat (solid form)	1 per 200 or per lot ^{a,c}	1 per 200 or per lot ^a	Each box	1 per 200 or per lot ^d	—
Weld Line—Grades E, X, G, S, and V—PSL-1						
—	—	1 per 400 welds or per weld lot ^a	1 per 400 welds or per weld lot ^a	All welds at 3 locations 120° apart	1 per 400 welds or per weld lot ^a	1 per 400 welds or per weld lot ^a
Weld Line—SS Grades						
—	—	1 per 200 welds or per weld lot ^a	1 per 200 welds or per weld lot ^a	All welds at 3 locations 120° apart	1 per 200 welds or per weld lot ^a	1 per 200 welds or per weld lot ^a
Weld Line—PSL-1, SR 23 (E.6)						
—	—	1 per 200 welds or per weld lot ^a	1 per 200 welds or per weld lot ^a	All welds at 3 locations 120° apart	1 per 200 welds or per weld lot ^a	1 per 200 welds or per weld lot ^a
Weld Line—PSL-2						
—	—	1 per 200 welds or per weld lot ^a	1 per 200 welds or per weld lot ^a	—	1 per 200 welds or per weld lot ^a	1 per 200 welds or per weld lot ^a
Weld Line—PSL-3						
—	—	1 per 100 welds or per weld lot ^a	1 per 100 welds or per weld lot ^a	—	1 per 100 welds or per weld lot ^a	1 per 100 welds or per weld lot ^a
^a Whichever is the smaller quantity. ^b Only required if a tensile specimen cannot be obtained from the pin tool joint. ^c As close as practicable to the tool joint shoulder unless otherwise specified in the purchase agreement. ^d This through-wall test is in addition to the test that is required for PSL-1, except for SS grades.						

Tables C.18 / D.18—~~HRC (HBW)~~ Hardness Limits for SS Grades

Grade	<u>Surface</u> Minimum ₁ surface ^a	<u>Through-wall Survey</u> ^a	
		Maximum, average	Maximum ₁ single reading
SS75 body	None	22.0 (237)	24.0 (247)
SS95 body	18.0 (216)	25.0 (253)	27.0 (264)
SS105 body	21.0 (231)	28.0 (271)	29.0 (279)
SS tool joint	24.0 (247)	30.0 (286)	32.0 (301)
SS weld zone	None	30.0 (286)	32.0 (301)
^a <u>Hardness values shown as HRC (HBW).</u>			

Annex G—Product Specification Levels

G.1 General

This annex describes product specification level (PSL) requirements for PSL-2 and PSL-3 that may be specified by the purchaser. The requirements of PSL-2 and PSL-3 are not applicable to SS grades. Higher PSL requirements may be furnished at the option of the manufacturer.

The requirements for PSL-2 and PSL-3 are in addition to those for PSL-1, which are the basis of this standard. All requirements for PSL-3 are in addition to requirements for PSL-2, except as otherwise indicated by PSL-3 requirements. Accordingly, in the body of this standard, provisions that give additional PSL-3 requirements are identified only as PSL-3. Those provisions that give PSL-2 requirements are identified as both PSL-2 and PSL-3 requirements.

G.3 Through-wall Hardness Testing of Tool Joints

G.3.2 Hardness-test locations

Hardness testing of tool joints for non-SS grades ~~other than SS~~ shall be carried out on a radial cross-section, taken at least one radius away from the ends of the tool joint or blank (see Figure B.14). These tests may be made at the thickest point in the tool joint material at the option of the manufacturer or when specified on the purchase agreement.

Hardness testing of the pipe body ~~effor~~ SS grades shall be carried out on a radial cross-section, taken at least one radius away from the end of the upset.

All four quadrants shall be tested. Testing on blocks is recommended rather than testing as a full ring to ensure ring overhang does not adversely affect the hardness test results.

When Rockwell testing is used, the first impression in each quadrant or test block shall be made near the center of the test specimen to seat the test specimen. The result of this impression shall be ignored.
