

API Ballot 6769

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Work Item Number	1079
Title of Work Item	Refresh to NACE TM0177-2024
Ballot Revision Level	1
Type of Ballot (Initial, Comment, Comment resolution (reference API ballot#), 1 st Re-ballot, 2 nd Re-ballot, etc.)	Initial
Submitter Name(s)	Brett Puckett
API Document Modified	API 5CT 11th Edition, Addendum 1
Impacted Documents	None
Revision Key	Current API document in black, Deletions in red strikethrough , Additions in red with gray highlight

Work Item Charge: Identify gaps between NACE TM0177-2016 and NACE TM0177-2024 and address points in API 5CT.

Ballot Rationale: NACE TM0177-2024 made improvements and added flexibility on test requirements. Refreshes in API 5CT documents were needed to avoid conflicts, such as:

- Method B: Changed from “bent beam” to “**three-point** bent-beam” test.
 - NACE TM0177-2024 made this change to avoid possible confusion with NACE TM0316 on four-point bend testing.
- NACE TM0177-2016 Solution A, Solution B, and Solution D included the combination of aqueous brine solution and test gas requirements. NACE TM0177-2024 standardized the Solution A, Solution B, and Solution D aqueous brine solution requirements and requires the test gas to be specified.
 - Test gas requirements added in the ballot **are technically consistent** with NACE TM0177-2016.
 - The pH requirements for Solution D **are technically consistent** with NACE TM0177-2016.
 - NACE TM0177-2024 requires pH to be specified for Solution D.
- Mechanical quality assurance of test results for Method D changed from informative in NACE TM0177-2016 to mandatory in NACE TM0177-2024.
- AMPP Standards Committees Operating Manual 18-April-2024 clause 5.4.2 states, “TMs contain procedures for conducting tests to ascertain the characteristics of a material, design, or operation. **TMs do not include pass/fail criteria for the material**, design, or operation being evaluated by the TM.

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Ballot Text:

2 Normative References

NACE ~~TM0177-2016~~TM0177-2024⁶, *Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking and Stress Corrosion Cracking in H₂S Environments*

3 Terms, Definitions, Symbols, Acronyms, and Abbreviations

3.2 Symbols

Sc minimum acceptable result of the NACE ~~TM0177-2016~~TM0177-2024 Method B test

6.10.5 Validation Requirements for Thick-walled Grades C90, T95, C110, and C125

6.10.5.1 General

Alternative hardenability requirements for thick-walled Grades C90, T95, C110, and C125, defined as tubular product with a wall thickness of 30 mm (1.181 in.) or larger, shall be permitted. Alternative hardness requirements shall be qualified through validation testing of specific samples according to NACE ~~TM0177-2016~~TM0177-2024 and the chemical, mechanical, and SSC test requirements according to API 5CT [grade, SR (as applicable) and SSC test method(s)]...

6.14.2 SSC Test Methods—Grades C90, T95, C110, and C125

The level of resistance to sulfide stress cracking shall satisfy the requirements in 6.14.4 using one or more of the following test methods as specified by the purchaser:

a) For Grades C90 and T95:

- 1) uniaxial tensile method (Method A);
- 2) ~~three-point~~ bent-beam method (Method B);
- 3) DCB method (Method D).

6.14.3 Test Solution

a) The following solutions ~~and test gases~~ shall be used for the tests identified in 6.14.2 for Grades C90, T95, and C110:

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1) Method A: NACE ~~TM0177-2016~~TM0177-2024, Solution A and saturated with chemically pure H₂S test gas;

2) Method B: NACE ~~TM0177-2016~~TM0177-2024, Section 9.3.1 and saturated with chemically pure H₂S test gas; or

NOTE The solution used for Method B is similar to Solution A for Method A but without the addition of NaCl.

3) Method D: NACE ~~TM0177-2016~~TM0177-2024, Solution A and saturated with chemically pure H₂S test gas.

An additional informative Method D (DCB) test may be specified according to A.11 (SR39) using NACE ~~TM0177-2016~~TM0177-2024 Solution D and saturated with test gas 7.0 ± 0.3 mol.% H₂S with balance N₂, an initial solution pH 3.8 to 4.0, and a final pH shall not exceed 4.6.

b) The following solutions and test gases shall be used for the tests identified in 6.14.2 for Grade C125:

1) Method A: NACE ~~TM0177-2016~~TM0177-2024 Solution B ~~modified such that it is and saturated with test gas 3.0 % (+0.3/-0.2 mol. %) H₂S, balance N₂ gas instead of saturated with chemically pure H₂S;~~

2) Method D: Options of solutions to test per NACE ~~TM0177-2016~~TM0177-2024:

— Solution D and saturated with test gas 7.0 ± 0.3 mol.% H₂S with balance N₂, an initial solution pH 3.8 to 4.0, and a final pH shall not exceed 4.6;

— Solution B ~~modified such that it is and~~ saturated with test gas 3.0 % (+0.3/-0.2 mol. %) H₂S, balance N₂ ~~gas instead of saturated with chemically pure H₂S.~~

Where NACE ~~TM0177-2016~~TM0177-2024 requires documented validation of test solution saturation, analysis shall be done using the iodometric titration procedure in NACE ~~TM0177-2016~~TM0177-2024 (Appendix C) or another validated and documented method.

6.14.4 Minimum SSC Requirements

a) NACE ~~TM0177-2016~~TM0177-2024 Method A, Uniaxial Tensile.

Each test specimen(s) shall not exhibit evidence of cracking, as evaluated per NACE TM0177-2024, following the test.

b) NACE ~~TM0177-2016~~TM0177-2024 Method B, ~~Three-Point~~ Bent Beam.

For Grades C90 and T95, the minimum acceptable result of the NACE ~~TM0177-2016~~TM0177-2024 Method B test...

c) NACE ~~TM0177-2016~~TM0177-2024 Method D (DCB).

7.12 Product Ends

7.12.7 End-sizing and Thermal Recovery

If the size of the deformed area does not allow for machining the minimum subsize test specimen indicated in ISO 6892-1 or ASTM A370 for tensile test, those of Table C.8 or Table E.8 for impact test, or those of NACE ~~TM0177-2016~~TM0177-2024 for SSC tests, the process shall be considered validated through the partial testing that can be performed (e.g., metallographic examination, hardness testing) and the corresponding requirements of Table I.1 or Table I.2.

If the size of the deformed area does not allow for machining the minimum subsize test specimen indicated in ISO 6892-1 or ASTM A370 for tensile test, those of Table C.8 or Table E.8 for impact test, or those of ~~TM0177-2016~~TM0177-2024 for SSC tests, the process shall be considered approved through the partial testing that can be performed (e.g., metallographic examination, hardness testing) and the corresponding requirements of Table I.3 or Table I.4.

9.10 Sulfide Stress Cracking (SSC) Test—Grades C90, T95, C110, and C125

9.10.1 General

NACE ~~TM0177-2016~~TM0177-2024 shall be used in conjunction with the requirements in 6.14 to determine the room temperature SSC resistance of Grades C90, T95, C110, and C125 products.

9.10.6 Invalidation of Tests

c) any identified cause of invalidation detailed in NACE ~~TM0177-2016~~TM0177-2024; for Method D, specific causes are found in paragraph 11.6.

For Method D, ~~the user may request the preparation of~~ the mechanical assurance graph, according to NACE ~~TM0177-2016~~TM0177-2024, Appendix ~~D~~G shall be performed to determine if test results are valid. ~~Invalidation of results based on the application of such appendix shall be accepted upon agreement between the manufacturer and the purchaser.~~ In NACE TM0177-2024 Figure G1, the regions labeled “Valid” and “Optional” shall be valid.

~~NOTE Refer to NACE TM0177-2016 Appendix D, Recommendation for Determining Mechanical Quality Assurance of Test Results for Method D (DCB test).~~

9.10.7 Additional Testing Provisions for NACE ~~TM0177-2016~~TM0177-2024, Method D

Table 19—Arm Displacement Values and Max/Min Tolerances

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Grade	SI Units (+0.03 mm/−0.05 mm)	USC Units (+0.001 in./−0.002 in.)
C90	0.76 mm	0.030 in.
T95	0.71 mm	0.028 in.
C110	0.51 mm	0.020 in.
C125 ^a	0.71 mm	0.028 in.
C125 ^b	0.41 mm	0.016 in.
<p>^a For Method D tests on Grade C125 conducted in Solution D with test gas 7.0 ± 0.3 mol.% H₂S with balance N₂, an initial solution pH 3.8 to 4.0, and a final pH shall not exceed 4.6 (see 6.14.3.b.2).</p> <p>^b For Method D tests on Grade C125 conducted in modified Solution B and saturated with test gas 3.0 +0.3/-0.2 mol. % H₂S, balance N₂ (see 6.14.3.b.2).</p>		

12 Documents

12.3 Certification Content

l) the information specified in the ~~TM0177-2016~~ TM0177-2024 Appendix D, Table D2A, “NACE Uniform Material Testing Report Form (Part 2): Testing in accordance with NACE TM0177 Method A—NACE Standard Tensile Test” shall be provided (where the mechanical tensile test result of the lot is accepted to be used in the SSC report);

m) the information specified in the TM0177-2024 Appendix D, Table D2B, “NACE Uniform Material Testing Report Form (Part 2): Testing in Accordance with NACE Standard TM0177 Method B—NACE Standard Three-Point Bent-Beam Test” shall be provided;

~~nn)~~ the information specified in the ~~TM0177-2016~~ TM0177-2024 Appendix, D Table D2D, “NACE Uniform Material Testing Report Form (Part 2): Testing in accordance with NACE TM0177 Method D—NACE Standard DCB Test” with supplemental information comprising crack length, the occurrence of dry cracks and dry crack length, and reason for invalidations for each specimen ~~(and when applicable the mechanical assurance curve according to NACE TM0177-2016 TM0177-2024 Appendix DG)~~ shall be provided;

Annex A**A.1 General****Table A.1—Supplementary Requirements Applicable to Couplings**

Requirement	SR
Statistical impact testing	A.7 (SR 12)
Seal-ring couplings	A.8 (SR 13)
Statistical tensile testing, Grades C90, T95, and C110	A.10 (SR 38)
Alternative NACE TM0177-2016 TM0177-2024 Method D SSC test, Grade C110	A.11 (SR 39)
Yield strength, Grade Q125	A.15 (SR 43)
Charpy V-notch test properties (shear area) for Grades N80, L80 Type 1, L80 3Cr, C90, R95, T95, P110, and Q125	A.16 (SR 44)
Hardenability, minimum percentage martensite required for quenched and tempered products	A.17 (SR 45)
SSC test, Grades C90 and T95 (Method A of NACE TM0177-2016 TM0177-2024, 90 % Y_{Smin})	A.18 (SR 46)

A.11 SR 39—Alternative NACE ~~TM0177-2016~~TM0177-2024 Method D Sulfide Stress Cracking Tests—Grade C110**A.11.1 SR 39.1—Test Requirements**

For each lot, as defined in 9.2, manufacturers shall carry out an NACE ~~TM0177-2016~~TM0177-2024 Method D test with the test solution specified in A.11.3 (SR 39.3). The test results shall not be used to determine conformance of the product to this standard.

A.11.3 SR 39.3—Alternative Test Solution

NACE ~~TM0177-2016~~TM0177-2024 test solution D and saturated with test gas 7.0 ± 0.3 mol.% H_2S with balance N_2 , an initial solution pH 3.8 to 4.0, and a final pH not exceeding 4.6 shall be used.

The test gas shall be premixed and certified by the provider of the gas.

The NACE ~~TM0177-2016~~TM0177-2024—Section ~~11.5.66.8~~ requirement for documented validation of test solution saturation shall include analysis using the iodometric titration procedure in NACE ~~TM0177-2016~~TM0177-2024—Appendix C or other validated and documented method.

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If Method A is specified for the SSC test (in accordance with ~~TM0177-2016~~TM0177-2024), manufacturers shall, for each lot as defined in 9.2, demonstrate that the product meets or exceeds the 90 % $Y_{s_{min}}$ requirement for three specimens, one each from the ends of three different products selected from sublots composed of the front one-third, middle one-third, and back one-third of the lot. The selection criteria in 9.10.4 shall apply to each of the sublots, including the random selection by agreement.

Table C.43—Marking Requirements and Sequence *(continued)*

Marking Sequence		Mark or Symbol ^b	Stencil and/or Stamp Marking Requirements ^a				
			Grades H40, J55, K55, N80, R95, and P110		Grades L80, C90, T95, C110, C125, and Q125		All Grades
			Pipe	Couplings	Pipe	Couplings	Coupling Stock and Accessory Material
1	2	3	4	5	6	7	8
14	Full-length drift test, if applicable: — Standard (casing or tubing)	D					
	— Alternative (casing or tubing) where « » is the size of the alternative drift	DA«....»					
	— For casing specified for tubing service and drift-tested in accordance with 7.10	DT42					
	All designations		P		P		
15	Serialization of Grades C90, T95, C110, C125, and Q125				D ^d or P	D ^d or P	P
16	Tin plating of couplings, if applicable	T		P		P	
17	Couplings H40, J55, and K55 only visually inspected	V		P			
18	Additional markings (see 10.1.10)		D or P	D or P	D or P	P	P

NOTE See 10.4 for mandatory color code requirements.

^a D = optional (die) stamping (for location, see 10.2.3); P = requirement for (paint) stenciling (for location, see 10.3).

^b A blank space, «....», indicates information to be filled in.

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- ^c The manufacturer may include "API" before "5CT."
- ^d Stamp marking shall conform to the requirements of 10.2.
- ^e Pipe can be identified as manufactured to SI units by the marked hydro-test pressure that will be less than 100 (MPa), whereas the pressure marked for pipe manufactured to USC units will be over 1000 (psi). This information is used to clearly identify the units used for CVN markings, which shall be in the same unit system as the pressure markings.
- ^f "A" when tested using Method A (smooth tensile), "B" when tested using Method B (three-point bent-beam), "D" when tested using Method D (DCB). If more than one test method is required, then state the combination of the test method designations as above, in alphabetical order. For example, if purchaser requires Method A and D, then mark "AD."
- ^g For Grades C90 and T95, "AH" when tested at 90 % Y_{Smin} .
- ^h See Table C.42 for thread type markings.
- ⁱ Marking to be applied to coupling blanks.

Annex E Tables in USC Units

Table E.43—Marking Requirements and Sequence *(continued)*

Marking Sequence		Mark or Symbol ^b	Stencil and/or Stamp Marking Requirements ^a				
			Grades H40, J55, K55, N80, R95, and P110		Grades L80, C90, T95, C110, C125, and Q125		All Grades
			Pipe	Couplings	Pipe	Couplings	Coupling Stock and Accessory Material
1	2	3	4	5	6	7	8
14	Full-length drift test, if applicable:						
	— Standard (casing or tubing)	D					
	— Alternative (casing or tubing) where « » is the size of the alternative drift	DA«....»					
	— For casing specified for tubing service and drift-tested in accordance with 7.10	DT42					
	All designations		P		P		
15	Serialization of Grades C90, T95, C110, C125, and Q125				D ^d or P	D ^d or P	P
16	Tin plating of couplings, if applicable	T		P		P	
17	Couplings H40, J55, and K55 only visually inspected	V		P			

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18	Additional markings (see 10.1.10)		D or P	D or P	D or P	P	P
NOTE See 10.4 for mandatory color code requirements.							
<p>a D = optional (die) stamping; P = requirement for (paint) stenciling.</p> <p>b A blank space, «...», indicates information to be filled in.</p> <p>c The manufacturer may include "API" before "5CT."</p> <p>d Stamp marking shall conform to the requirements of 10.2.</p> <p>e Pipe can be identified as manufactured to SI units by the marked hydro-test pressure that will be less than 100 (MPa), whereas the pressure marked for pipe manufactured to USC units will be over 1000 (psi). This information is used to clearly identify the units used for CVN markings, which shall be in the same unit system as the pressure markings.</p> <p>f "A" when tested using Method A (smooth tensile), "B" when tested using Method B (three-point bent-beam), "D" when tested using Method D (DCB). If more than one Test Method is required, then state the combination of the test method designations as above, in alphabetical order. For example, if purchaser requires Method D and A, then state and mark "AD."</p> <p>g For Grades C90 and T95, "AH" when tested at 90 % Y_{Smin}.</p> <p>h See Table E.42 for thread type markings.</p> <p>i Marking to be applied to coupling blanks.</p>							

Annex I

I.2 Test Specimens

For Grades C90, T95, and C110, sour service tests shall be performed on NACE ~~TM0177-2016~~TM0177-2024, Method A and/or Method D, specimens. When applicable, the test specimen sizes, method, and acceptance criteria shall be in accordance with 6.14 and 9.10.

I.3.3.4 SSC Testing

The sulfide stress-cracking tests shall meet the minimum requirement specified in 6.14.4. If ~~TM0177-2016~~TM0177-2024 (Method D), sub-size, or alternative specimens are used, the acceptance criteria shall be agreed upon between the purchaser and manufacturer.

I.4.3.3 SSC Testing

When specified in the purchase agreement, sulfide stress-cracking testing shall be performed. The tests shall meet the minimum requirement specified in 6.14.4. When NACE ~~TM0177-2016~~TM0177-2024 (Method D), sub-size, or alternative specimens are used, the acceptance criteria shall be agreed upon between purchaser and manufacturer.