

Recommended Practice for Application of Cement Lining To Steel Tubular Goods, Handling, Installation, and Joining

API RECOMMENDED PRACTICE 10E
THIRD EDITION, SEPTEMBER 1, 1994

Contains ISO 10409:1993

**Petroleum and natural gas industries—Application of cement lining to steel
tubular goods, handling, installation, and joining**

American Petroleum Institute
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Exploration and Production Department

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FOREWORD

Note: This section is not part of ISO 10409:1993.

API Recommended Practice 10E serves as the basis for ISO 10409:1993. The complete text of both the API and ISO standards is contained in this document. Some differences exist between the API version and the ISO version of this standard; for example:

- The Special Notes and Foreword are not part of ISO 10409:1993.
- The text that is shaded is not part of ISO 10409:1993.
- Appendix D is not part of Recommended Practice 10E.

Language that is unique to the ISO version is shown in ***bold oblique type*** in the text or, where extensive, is identified by a note under the title of the section. Language that is unique to the API version is identified by a note under the title of the section or is shaded. The bar notations identify parts of this publication that have been changed from the previous API edition.

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This edition of API RP 10E supercedes the second edition dated July 1, 1987.

Recommended Practice for Application of Cement Lining to Steel Tubular Goods, Handling, Installation, and Joining

1 Scope

1.1 The purpose of this recommended practice is to provide standard procedures for the plant application of cement lining to oil field tubular goods and recommended methods for joining cement-lined pipe.

1.2 This recommended practice is under the jurisdiction of the API Committee on Standardization of Well Cements. It was developed through the joint effort of members of National Association of Corrosion Engineers (NACE) T-1G-8 Task Group on Cement Lining of Tubular Goods and API Task Group on Cement Lining of Steel Pipe. It was also submitted to NACE Unit Committee T-1G for review and comments.

1.3 These recommendations apply to cement lining of steel pipe and tubing used for shielding the steel from chemical corrosive attack encountered in the handling of oil field brines. This recommended practice suggests minimum requirements and should in no way be interpreted as a restriction on the use of other procedures or materials. Neither is this recommended practice intended to apply in all cases relating to the subject. Environment may negate the usefulness of cement linings in specific instances.

1.4 *Cement lining and cement-lined* as used in this recommended practice refer to the cement-mix proportions as set forth in 4.2.1.

2 References

2.1 STANDARDS

The most current editions of the following standards are referenced in this recommended practice:

API

- Spec 5CT *Specification for Casing and Tubing [ISO 11960, In process]*
- Spec 5L *Specification for Line Pipe [ISO 3183-1]*
- Spec 10 *Specification for Materials and Testing for Well Cements [ISO 10426]*

ASTM¹

- C 33 *Specifications for Concrete Aggregates (Part 14)*
- A 53 *Specifications for Welded and Seamless Steel Pipe (Part 1)*
- C 76 *Specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Part 12)*

¹American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103-1187.

- C 109 *Test for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens) (Part 13)*
- C 150 *Specifications for Portland Cement (Part 13)*
- C 618 *Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete (Part 14)*

SSPC²/NACE³

- SSPC-SP-1 *Solvent Cleaning*
- SSPC-SP-4 *Flame Cleaning*
- SSPC-SP-6 *Commercial Blast Cleaning (NACE No. 3)*
- SSPC-SP-10 *Near-White Blast Cleaning (NACE No. 2)*

2.2 OTHER REFERENCES

Earlier work investigating the application and use of cement linings in tubular goods was conducted by NACE Technical Unit Committee T-1G (Protective Coatings and Non-Metallic Materials for Oil Field Use). The following report contains committee findings that have been widely used as the basis for cement lining specifications:

NACE³

Technical Committee Report 1G163—*Recommended Practices Applicable to Placing Cement Lining in Oil Field Steel Tubular Goods*

Beyond the scope of this recommended practice, certain standards covering other applications and uses of cement linings may be useful and are listed as follows:

ANSI⁴

- A21.4 *Cement-Mortar Lining for Cast Iron and Ductile Iron Pipe and Fittings for Water*

AWWA⁵

- C-602 *Cement-Mortar Lining of Water Pipelines in Place*
- C-205 *Cement-Mortar Protective Lining and Coating for Steel Water Pipe—4 inches and Larger—Shop Applied*

² Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh, Pennsylvania 15213-2683.

³ National Association of Corrosion Engineers, P.O. Box 218340, Houston, Texas 77218.

⁴ American National Standards Institute, 11 West 42nd Street, New York, New York 10036.

⁵ American Water Works Association, 6666 West Quincy Avenue, Denver, Colorado 80235.

2.3 BIBLIOGRAPHY

The following publications contain information on this subject:

H. J. Beach, *et al.*, *Causes and Prevention of Failures in Cement Pipe Linings*, Society of Petroleum Engineers of AIME, Paper Number SPE 2478, 1969.

R. H. Bogue, *The Chemistry of Portland Cement*, Reinhold Publishing Company, New York, 1947.

R. W. Elliott and R. S. Landley, *Welded Cement-Lined Pipe for Corrosive Fluids*, API Drilling and Production Practice 71, American Petroleum Institute, Washington, DC, 1961.

Fly Ash Increases Resistance of Concrete to Sulfate Attack, Report Number C-1224, U.S. Department of the Interior, Bureau of Reclamation, January 1967.

F. M. Lea, *The Chemistry of Cement and Concrete*, 3rd edition, Edward Arnold, London, 1970.

MRD 453-16-R, Company Report, Halliburton Oil Well Cementing Company, March 25, 1958.

E. E. Runyon, *An Engineered Approach to Cement-Lined Tubing*, Society of Petroleum Engineers of AIME, Paper Number SPE 995, 1964.

E. E. Runyon, "How Cement Lining Can Protect Your Pipe," *Oil and Gas Journal*, July 22, 1963.

Symposium on Use of Pozzolanic Materials in Mortars and Concrete, First Pac. Ar. Nat. Meeting, American Society for Testing and Materials, Philadelphia, PA, 1949.

R. G. Walker, "The Origin and Significance of the Internal Sedimentary Structures of Turbidites," *Proceedings—Yorkshire Geo. Soc.*, June 1965, 35, Part 1, Number 1.

3 Material

3.1 PIPE AND TUBING FOR LINING WITH CEMENT

Steel pipe and tubing to be cement-lined may be either new or used at the discretion of the purchaser. The purchaser is expected to furnish the pipe to be lined or to provide specifications therefor, and is responsible for compatibility of the pipe with maximum stress, stress fluctuation, and environmental stress cracking resistance requirements. The applicator should inspect and segregate all pipe that in his opinion cannot be lined satisfactorily or that has defects that would prevent satisfactory performance after lining. The purchaser may request the lining of such pipe either as it is or after straightening and drifting. Unless previously agreed upon, the applicator is not responsible for the successful lining of pipe that was originally rejected. The purchaser is responsible for the handling and replacement of pipe rejected initially by the applicator.

3.1.1 New Pipe and Tubing for Lining With Cement

The pipe or tubing to be lined should be in accordance with dimensional specifications contained in API Specification 5CT [*ISO 11960, in process*] or 5L [*ISO 3183-1*]. While generally it should be expected that pipe to these specifications would meet the applicator's tolerances on eccentricity, straightness, dents, flats, burrs, or whiskers, pipe and tubing can meet the API specifications and still be unacceptable for cement lining. The applicator may request replacement of such material or, at the purchaser's request, may apply linings in accordance with the limitations indicated in 3.1. New steel pipe and tubing to be cement-lined should meet the following:

- Tolerances in the pipe should be limited to a maximum misalignment, in any length of pipe to be lined, of no more than the tolerance variation allowed in the cementing thickness listed in Table 1.
- Maximum out-of-roundness, as the difference between maximum and minimum diameters, should not exceed $\frac{1}{32}$ inch (0.8 millimeter) or 0.5 percent of the nominal outside diameter (OD), whichever is larger. Out-of-round pipe should be set aside and appropriately marked.
- Minimum wall thickness should be 0.125 inch (3.18 millimeters) for pipe of $4\frac{1}{2}$ -inch (114.3-millimeter) OD and under, and 0.156 inch (3.96 millimeters) in pipe $4\frac{1}{2}$ -inch (114.3-millimeter) OD through $6\frac{5}{8}$ -inch (168.3-millimeter) OD. Minimum wall thickness of pipe over $6\frac{5}{8}$ -inch (168.3-millimeter) OD should be by agreement between purchaser and applicator.
- Length of the pipe or tubing and length tolerance should be by agreement between the applicator and the purchaser.
- Pipe wall should be free of dents or flats and the internal surface free of burrs and whiskers. Their presence should be cause for rejection.
- Fittings should be inspected for defects by the applicator and unsuitable fittings rejected. The purchaser may request the lining of rejected fittings to be subject to the same limitations contained in 3.1. The applicator's inspection should be limited to the suitability of the items to be successfully lined. If fitting inspection is to include dimensional inspection, this should be by agreement between the applicator and the purchaser.

3.1.2 Used Pipe and Tubing for Lining With Cement

3.1.2.1 The lining of used pipe should be at the discretion of the purchaser and to his specifications generally. Section 4.1 is suggested as a guide for cleaning the pipe and should be subject to the same conditions as set forth in 3.1.

3.1.2.2 The applicator is expected to make a visual inspection of all pipe or tubing received and to discard all ob-

viously defective joints (bent, mashed, those with deep external or internal pitting, and those with internal seams). These should be marked as not suitable for coating. The applicator is expected to inform the purchaser of any unacceptable material in order that replacement material may be obtained.

3.1.2.3 API Specification 5L [ISO 3183-1], Table on Tolerances on Dimensions and Weights, is applicable for tolerances on dimensions of used pipe and tubing.

3.2 CEMENT

3.2.1 Cement meeting the requirements of API Class C (similar to ASTM C 150 Type III) high sulfate resistant (HSR) cement as set out in the latest edition of API Specification 10 [ISO 10426], with zero tricalcium aluminate (C_3A), should be used for lining oil field pipe and tubing. This cement is suitable for exposure to corrosive waters, regardless of the soluble sulfate concentration and is therefore the cement preferred by most users.

3.2.2 When API Class C cement with zero C_3A is unavailable, other cements may be used but only upon specific approval by the purchaser.

a. Moderate sulfate resistant (MSR) cements (having less than 8 percent C_3A) may be used when the corrosive fluid contains less than 1000 parts per million soluble sulfates. These may be either API Class B (MSR) or Class C (MSR) cement.

b. High sulfate resistant (HRS) cements (having less than 3 percent C_3A) should always be used when the corrosive water contains 1000 parts per million or higher soluble sulfates. These may be either API Class B (HRS) or Class C (HRS) cement.

3.2.3 The purchaser of cement-lined pipe may require the applicator to furnish a written statement of the chemical composition of the cement for the purchaser's approval. Similarly, the applicator may require the cement manufacturer to furnish a written statement of the chemical composition of the cement for approval by the applicator or by the purchaser of the cement-lined pipe. The method for determining the C_3A content of the cement selected should be by mutual agreement among the cement manufacturer, the applicator, and the purchaser of the cement-lined pipe.

3.2.4 Cement manufacturing companies and products suitable for cement lining applications are listed in the Appendix on Fly Ash, Bentonite, or both of API Specification 10 [ISO 10426].

3.2.5 The cement used for cement lining oil field pipe and tubing should be uniform and free of lumps.

3.3 SAND

3.3.1 Sand should be at least 95 percent quartz (silicon dioxide) and should not lose more than 0.5 percent on ignition.

3.3.2 The sand should meet ASTM C 33 and conform to the following screen analyses:

U.S. Series Sieve No.	Percent Retained on Each Sieve
16	0
30	0-5
40	15-25
50	49-60
80	20-4
100	0-5
<100 (Pan)	0-2

3.4 POZZOLANIC MATERIALS

3.4.1 Fly ash and raw or calcined pozzolans should conform to ASTM C 618 and API Specification 10 [ISO 10426]. The loss on ignition for fly ash, conforming to ASTM C 618, should not exceed 4 percent.

3.4.2 The purchaser may require the applicator to furnish satisfactory reports of analyses that certify that the pozzolanic materials meet the ASTM requirements set forth in 3.4.1.

3.5 WATER

For mixing the lining material, clear potable water should be used.

3.6 CHEMICAL ADDITIVES

Chemical admixtures may be used by agreement between the applicator and purchaser.

3.7 STORAGE AND HANDLING

Cement, sand, and pozzolans should be kept clean, dry and free from contaminants. They should be stored in separate bins, tanks, or other containers closed to weather and contamination. Cement and pozzolans should be passed through a $\frac{1}{4}$ -inch (6.4-millimeter) or less mesh screen to remove lumps and other extraneous matter before mixing. All materials should be handled and transferred in such a manner that all foreign matter is excluded.

4 Method of Lining Pipe and Tubing With Cement Lining

4.1 PIPE

4.1.1 New and used pipe and tubing should be free of mill varnish, oil, paraffin, corrosion products, mill scale, thread lubricant, or any other foreign material when the wet cement mix is introduced for lining.