



Standard Test Method for Cathodic Disbonding of Pipeline Coatings by Laboratory Simulation of Soil Burial¹

This standard is issued under the fixed designation D 6190; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers an accelerated procedure for determining the relative disbonding characteristics of electrically insulating coating systems applied to steel pipe exteriors. The coating is applied for the purpose of preventing or mitigating corrosion that may occur in underground service. The pipe may be exposed to elevated temperatures while under cathodic protection. This test method is intended for use with samples of coated pipe taken from commercial production and is applicable to such samples when the coating functions as an electrical barrier.

1.2 The values stated in SI units to three significant figures are to be regarded as the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method²

G 12 Test Method for Nondestructive Measurement of Film Thickness of Pipeline Coatings on Steel³

G 19 Test Method of Test for Disbonding Characteristics of Pipeline Coatings by Direct Soil Burial³

3. Summary of Test Method

3.1 An apparatus is described in which soil is brought in contact with a coated pipe sample under conditions that simulate soil burial. The specimens with intentionally damaged areas are electrically connected to a rectifier to apply an electrical stress. A highly conductive soil mixture consisting of electrolyte soaked sand is used to accelerate the test. After test, the disbonded areas of coating are removed and the exposed area is measured.

3.2 The cathodic stress may be applied under conditions of a constant level elevated temperature.

3.3 Physical examination is conducted by comparing the extent of loosened or disbonded coating at the perforations in the soil exposed area with the extent of loosened or disbonded coating at a new test hole in the coating made in an area that was not exposed to soil.

4. Significance and Use

4.1 Damage to pipe coating is almost unavoidable during transportation and construction. Breaks or holidays in pipe coatings may expose the pipe to possible corrosion, since after a pipe has been installed underground, the surrounding soil could be an effective electrolyte. These coatings are generally used under cathodic protection conditions; damaged areas in them can enlarge to an extent that would not allow the cathodic protection to be effective. Elevated temperature increases the tendency of coatings to disbond, however, there may be a considerable difference in the tendency to disbond in the ground and in the laboratory electrolyte test. It is therefore appropriate for some coatings to test cathodic disbonding in soil both at room and elevated temperatures. The test is accelerated by using sand soaked with electrolyte as the conducting medium.

4.2 When compared to field testing of samples outdoors in soil, the method described here offers better control, uses less soil, and can be performed in the laboratory. In addition, the use of highly conductive electrolyte-soaked sand results in significant acceleration of the test over Test Method G 19.

4.3 The physical examination is made easier by comparing the adhesion of the coating to that obtained at a section not exposed to the soil. This is assumed to be the maximum adhesion or bond as measured by the lifting technique used and that the same lifting technique can be used at a test hole that was exposed to the soil. This provides a means of comparing the relative resistance to lifting.

4.4 It is assumed that any relatively lesser bonded area at the exposed test holes in the coating was caused by electrical stressing.

5. Apparatus

5.1 The soil simulation test apparatus is shown schematically in Fig. 1. Drawings for the aluminum lower seal, plastic top plate, aluminum top seal, and plastic main body are shown in Fig. 2. These drawings will enable the construction of an

¹ This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.48 on Durability of Pipeline Coating and Linings.

Current edition approved Nov. 10, 1997. Published February 1998.

² Annual Book of ASTM Standards, Vol 14.02.

³ Annual Book of ASTM Standards, Vol 06.02.

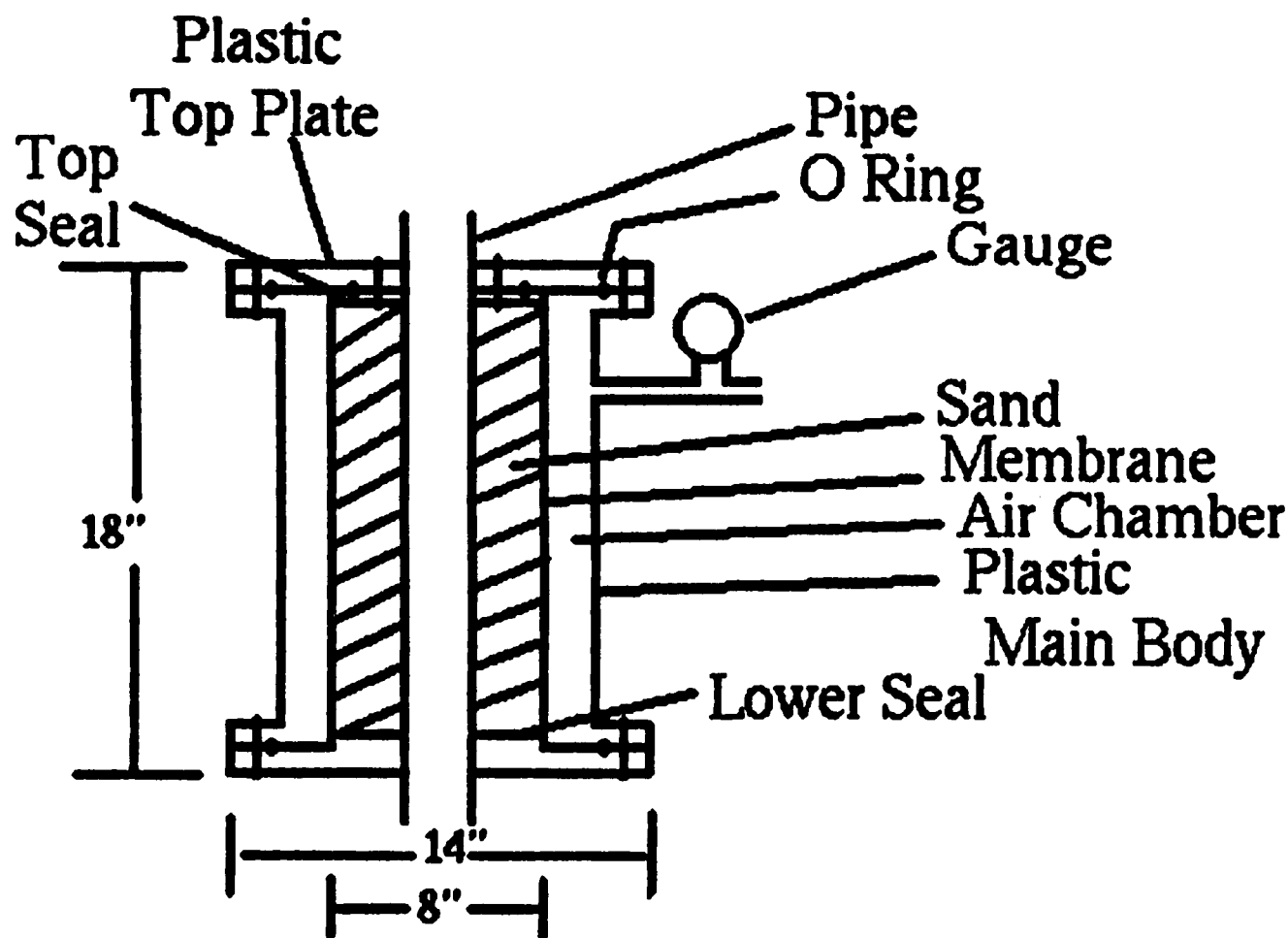


FIG. 1 Soil Simulator Apparatus

apparatus by the user. The coated pipe specimen is placed in the center of the apparatus surrounded by the sand. The sand is held in place with a rubber membrane in the shape of a cylinder that transmits the air pressure on the outside of the membrane and the outer plastic cylinder can be pressurized with air. This effectively reproduces any desired radial force on the soil/pipe interface. The “O” rings on the top and lower seal plates seal the air chamber between the plastic cylinder and the rubber membrane. Thus, there is no air seal between the sample and the soil. A pressure gage reads the air pressure in the chamber that can be controlled by a regulator. The pressure used to simulate the burial depth varies with the density of soil and is given in Fig. 3 for densities of 23.0 kN/m^3 (125 lb/ft^3) to 15.7 kN/m^3 (80 lb/ft^3).

5.1.1 With noncohesive soils, such as sand, a rubber diaphragm end seal is used to prevent leakage of soil sample. The rubber seal is in the shape of a circle cut in the center to allow a tight fit for the test pipe. The rubber seal is placed on the pipe specimen before the pipe is placed in the apparatus as shown in Fig. 4.

5.1.2 The apparatus is sized for a 5-cm (2-in.) nominal pipe diameter, 61 cm (24 in.) long with a 20.3-cm (8-in.) soil diameter. However, it can easily be scaled for larger diameter pipe. In order to determine the cathodic disbondment as a

function of temperature of the pipe, a cartridge heater⁴ and thermocouple are inserted in the center of the specimen and surrounded by copper chips or steel shot. The copper chips or steel shot effectively maintain a uniform temperature throughout the interior of the sample. This arrangement has been found to be superior to using circulating oil as the heating medium, however, a circulating oil system is acceptable.

5.2 Miscellaneous Apparatus:

5.2.1 *Connectors*—Wiring from anode to test specimen shall be 4107-cmil (14-gage Awg) minimum, insulated copper. Attachment to the test specimen shall be by soldering, brazing or bolting to the unburied end, and the place of attachment shall be coated with an insulating material. A junction in the connecting wire is permitted provided that it is made by means of a bolted pair of terminal lugs soldered or mechanically crimped to clean wire ends.

5.2.2 *Holiday Tools*—Holidays shall be made with conventional drills of the required diameter. For use in preparing small

⁴ The sole source of supply of the heater, Model CIR-5177, 850 W, 451 mm (17.75 in.) long, known to the committee at this time is Capp Inc., 6 Beacon Street, Boston, MA 02108. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

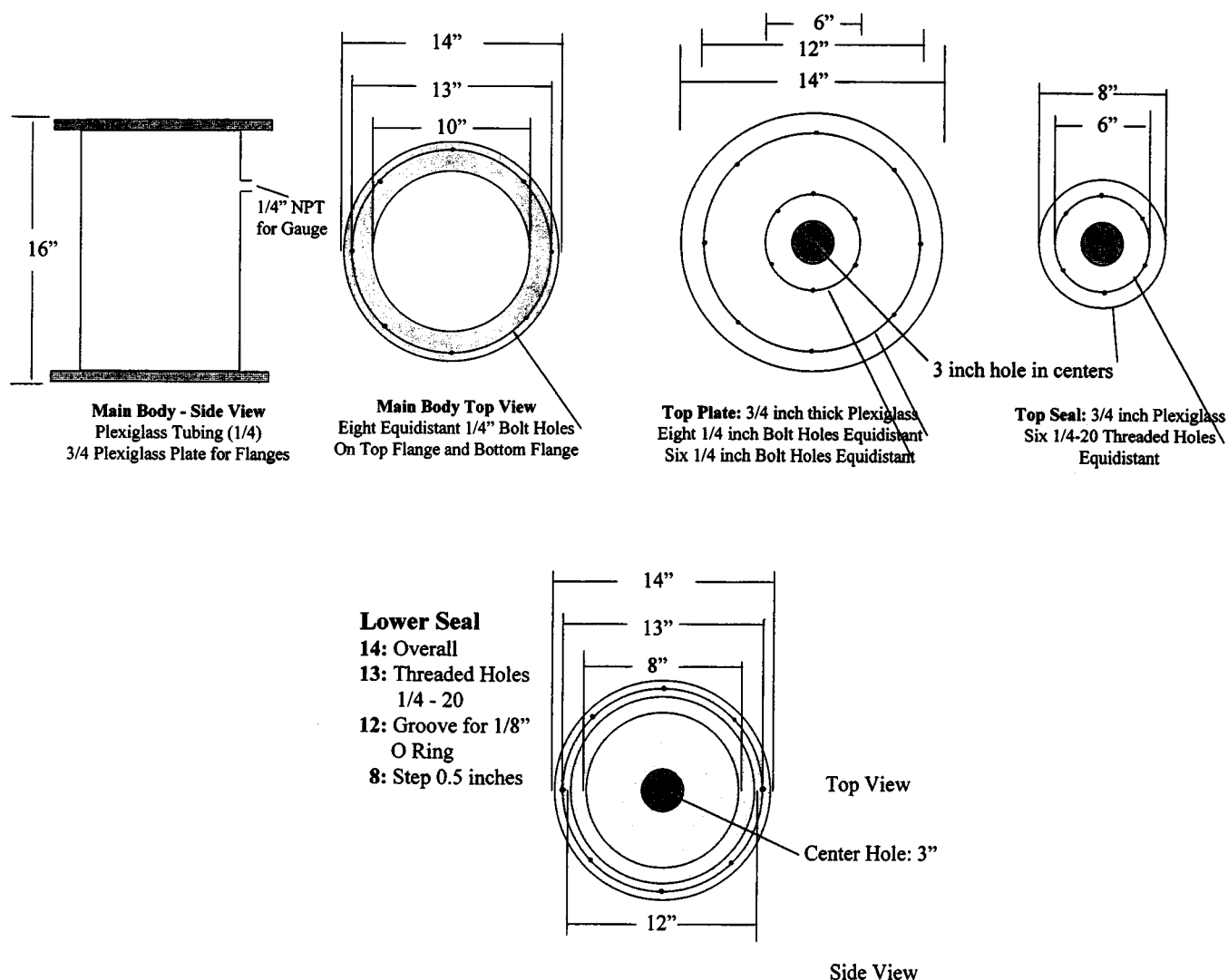


FIG. 2 Soil Simulator Parts

diameter pipe specimens such as 19.05-mm (0.75-in.) nominal diameter pipe, the use of a drill modified by substantially grinding away the sharp cone point has been found effective in preventing perforation of the metal wall of the pipe. A sharp pointed knife with a safe handle is required for use in making physical examinations.

5.2.3 *High Resistance Voltmeter*, for direct current having an internal resistance of not less than 10 megohms and having a range of 0.01 to 5 V for measuring potential to the reference electrode.

5.2.4 *Reference Electrode*, saturated Cu/CuSO₄, of conventional glass or plastic tube with porous plug construction, preferably not over 10.05-mm (0.75-in.) in diameter, having a potential of -0.316 V with respect to the standard hydrogen electrode. A calomel electrode may be used, but measurements made with it shall be converted to the Cu/CuSO₄ reference for reporting by adding -0.072 V to the observed reading.

5.2.5 *Thickness Gage*, for measuring coating thickness in accordance with Test Method G 12.

5.2.6 *Thermometer*, for measuring electrolyte temperature, general lab type, 1° subdivisions, 76.2 mm (3 in.) immersion.

5.2.7 *Precision Wire Wound Resistor*, 1 Ω ± 1%, 1 W

(minimum), to be used in the test cell circuit as a shunt for current.

5.2.8 *Volt-Ohm Meter*, for initial testing of apparent coating resistance.

5.2.9 *Additional Connecting Wires*, 4107-cmil (14-gage Awg) minimum, insulated copper.

5.2.10 *Brass Studs*, used at a terminal board, together with alligator clips or knife switches, for making and breaking circuits. However, alligator clips shall not be used to connect to electrodes or specimens at the top location of test cells.

5.2.11 *Direct Current Rectifier*, capable of supplying constant voltage at a voltage of 1.5 ± 0.01 V, as measured between the specimen and reference electrode.

5.2.12 *Impressed Current Anode*, shall be of the nonconsumable type provided with a factory sealed, insulated copper wire. Platinum clad anodes, 3.2 by 610 mm (1/8 by 24 in.) have been found useful.

6. Reagents and Materials

6.1 The electrolyte to be added to the sand shall consist of potable tap water or higher purity water (distilled or demineralized water is satisfactory) with the addition of 3 weight % of