



# Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines<sup>1</sup>

This standard is issued under the fixed designation C 969; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope

1.1 This practice covers procedures for testing installed precast concrete pipe sewer lines using either water infiltration or exfiltration acceptance limits to demonstrate the integrity of the installed materials and construction procedure.

1.2 A complete metric companion to this practice has been developed—C 969M; therefore, no metric equivalents are presented in this practice.

NOTE 1—The owner shall specify the following: who will conduct, observe, and furnish labor, furnish material and measuring devices, and pay for the tests; who is responsible for determining local groundwater conditions; and which test is to be conducted, that is, an infiltration test or an exfiltration test.

NOTE 2—The user of this practice is advised that test criteria presented in this practice are similar to those in general use. Pipe, 24-in. diameter or larger, may be accepted by visual inspection when testing for infiltration.

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:

C 822 Terminology Relating to Concrete Pipe and Related Products<sup>2</sup>

## 3. Terminology

3.1 *Definitions*—For definitions of terms relating to concrete pipe, see Terminology C 822.

## 4. Summary of Practice

4.1 Determine the groundwater conditions surrounding the section of sewer to be tested and select the type of test to be conducted.

4.2 For the infiltration test, the amount of water leaking into the sewer line is measured, and the rate of infiltration is determined. If the rate is less than or equal to the allowable limit, the section of sewer tested is acceptable.

4.3 For the exfiltration test, the sewer line is filled with water to the specified test head and the rate of water loss is determined. If the rate is less than or equal to the allowable limit, the section of sewer tested is acceptable.

## 5. Significance and Use

5.1 This is not a routine test. The values recorded are applicable only to the sewer being tested and at the time of testing.

## 6. Preparation of the Sewer Line

6.1 The sewer shall be free of debris prior to testing.

6.2 The manholes, the ends of the branches, laterals, wyes and stubs to be included in the test shall be plugged. All plugs shall be secured to prevent leakage blowout due to testing pressure.

## 7. Procedure

### 7.1 Infiltration Testing:

7.1.1 Conduct testing from manhole to manhole or between more than two manholes. The length of main tested shall not exceed 700 ft.

7.1.2 Stop all dewatering operations and allow the groundwater to return to its normal level. Infiltration testing shall not be used unless the groundwater level is at least 2 ft above the crown of the pipe for the entire length of the test section.

7.1.3 Plug all pipe outlets discharging into the upstream manhole.

7.1.4 Measure the groundwater elevation and determine the average head over the test section.

7.1.5 Measure infiltration leakage at the outlet of the test section. Because leakage allowances are small, measurements are best made by either timing the filling of a small container of known volume, or by directing flow into a container for a specified time and measuring the content, or by using small weirs.

7.1.6 If the measured rate of leakage is less than or equal to

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.05.

the allowable leakage in accordance with 8.1, the section of sewer tested is acceptable.

7.1.7 If the test section fails, it is not prohibited that it be repaired and retested in accordance with this practice.

**7.2 Exfiltration Testing:**

7.2.1 Conduct testing from manhole to manhole or between more than two manholes. The length of main tested shall not exceed 700 ft.

7.2.2 Determine the groundwater elevation at both ends of the test section. If the groundwater level is less than 2 ft above the crown of the pipe measured from the highest elevation of the sewer, the exfiltration test shall be used.

7.2.3 Plug all pipe outlets discharging into the upstream manhole and the test section outlet. Fill the sewer line with water.

7.2.4 At the upstream manhole the test head shall be established as minimum of 2 ft above the crown of the pipe, or at least 2 ft above existing groundwater, whichever is higher.

7.2.5 Allow the pipe to remain saturated for a period long enough to allow water absorption in the pipe, a minimum of 4 h and up to a maximum of 72 h. After the absorption period, refill the pipe to the required test head.

7.2.6 Measure the leakage loss over a timed test period. The minimum test period shall be 15 min and the maximum shall not exceed 24 h.

7.2.7 If the measured rate of leakage is less than or equal to the allowable leakage in accordance with 8.2, the section of sewer tested is acceptable.

7.2.8 If the test section fails, it is not prohibited that it be repaired and retested in accordance with this practice. The groundwater elevation shall be redetermined prior to a second test and the test head adjusted, if necessary, in accordance with 7.2.4.

**8. Leakage Criteria**

**8.1 Infiltration Testing:**

8.1.1 For infiltration testing, the allowable leakage limit including manholes is 200 gal/(in. of internal diameter) (mile

of sewer) (24 h) when the average head on the test section is 6 ft or less.

NOTE 3—The average head on the test section is the head above the crown of the pipe at the upstream manhole plus the head above the crown of the pipe at the downstream manhole divided by two.

8.1.2 When the average groundwater head on the test section is greater than 6 ft, the allowable leakage shall be increased in proportion to the ratio of the square root of the average groundwater head to the square root of the base head of 6 ft.

8.1.3 Manholes shall be tested separately and independently or with the pipeline with the allowance of 0.1 gal/(ft of diameter) (ft of head) (h). If building or house leads are connected to the main line being tested, allowance shall be made for permissible leakage in such leads.

**8.2 Exfiltration Testing:**

8.2.1 For exfiltration testing the allowable leakage limit including manholes is 200 gal/(in. of internal diameter) (mile of sewer) (24 h) when the average head on the test section is 3 ft or less.

8.2.2 When the average head on the test section is greater than 3 ft, the allowable leakage shall be multiplied by the ratio of the square root of the average test head and the square root of the base head of 3 ft.

8.2.3 Manholes shall be tested separately and independently or with the pipeline with an allowance of 0.1 gal/(ft of diameter) (ft of head) (h).

**9. Calculation**

9.1 Sample calculations are presented in the Appendix.

**10. Precision and Bias**

10.1 No justifiable statement is presently capable of being made either on precision or on bias of these procedures since the test results merely state whether there is conformance to the criteria for the success specified. Due to the sealing effects of groundwater, internal flow in the sewerline, and test water, the test conditions and results are not reproducible.

**APPENDIX**

**(Nonmandatory Information)**

**X1. APPLICATION OF THE PRACTICE**

X1.1 The following examples have been prepared to demonstrate the technique of applying this practice:

X1.1.1 *Example 1:* A sewer line is to be tested for infiltration. The sewer line is a 12-in. diameter pipe with the groundwater head over the upstream manhole of 9 ft and a groundwater head over the downstream manhole of 11 ft. The distance between manholes is 400 ft.

X1.1.1.1 *Find:* The appropriate allowable rate of infiltration leakage per hour of test.

X1.1.1.2 *Solution:* The average test head in feet is:

$$\text{Test head} = [(9 + 11)/2] = 10 \quad (\text{X1.1})$$

Since the test head is greater than the base head (6 ft), the allowable rate of 200 gal/(in. diameter) (mile) (24 h) must be multiplied by the ratio of the square root of the average groundwater head (10 ft) and the square root of the base head (6 ft) or:

$$\begin{aligned} \text{Allowable leakage} &= 200 \times \frac{\sqrt{10}}{\sqrt{6}} \\ &= 258 \text{ gal/(in. diameter) (mile) (24 h)} \end{aligned} \quad (\text{X1.2})$$

Conversion of this rate to the allowable leakage for the

above line in gallons per hour gives:

$$\begin{aligned} \text{Allowable leakage: } & 258 [12 \text{ (diameter)} \\ & \times 400 \text{ (ft)/24 (h)} \times 5280 \text{ (ft/mile)}] \\ & = 9.77 \end{aligned} \quad (\text{X1.3})$$

X1.1.1.3 *Answer:* 9.77 gal/h.

X1.1.2 *Example 2:* A sewer line is to be tested for exfiltration as the groundwater level is below the crown of the pipe at the upstream manhole. The sewer line is an 18-in. diameter pipe with a specified test head of 2 ft over the crown of the pipe at the upstream manhole. The sewer line test section is 400 ft long between manholes on a slope of 1.0 %.

X1.1.2.1 *Find:* The appropriate allowable rate of exfiltration leakage per hour of test.

X1.1.2.2 *Solution:* The average test head in feet is:

$$\text{Test head} = \frac{(400 \times 0.01 + 2) + 2}{2} = 4 \quad (\text{X1.4})$$

Since the test head is greater than the base head (3 ft), the allowable rate of 200 gal/(in. diameter) (mile) (24 h) must be multiplied by the ratio of the square root of the test head and the square root of the base head (3 ft) or:

$$\begin{aligned} \text{Allowable leakage} &= 200 \times \frac{\sqrt{4}}{\sqrt{3}} \\ &= 231 \text{ gal/(in. diameter) (mile) (24 h)} \end{aligned} \quad (\text{X1.5})$$

Conversion of this rate to the allowable leakage for the above line in gallons per hour gives:

$$\begin{aligned} \text{Allowable leakage} &= 231 [18 \text{ (diameter)} \times 400 \text{ (ft)/24 (h)} \\ & \times 5280 \text{ (ft/mile)}] \\ &= 13.1 \end{aligned} \quad (\text{X1.6})$$

X1.1.2.3 *Answer:* 13.1 gal/h.

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