UNI-BELL PVC PIPE ASSOCIATION

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RECOMMENDED PRACTICE FOR LOW-PRESSURE AIR TESTING OF INSTALLED SEWER PIPE

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UNI-BELL PVC PIPE ASSOCIATION

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Recommended Practice

FOR LOW-PRESSURE AIR TESTING OF INSTALLED SEWER PIPE

FOREWORD

This recommended practice is intended for use as a document to be referenced in project specifications and contract documents relative to the performance testing of installed wastewater collection lines.

In the not too distant past, sewers were installed with little regard to low infiltration service and watertight construction. However, it was not long after the advent and logical acceptance of separate sanitary sewer systems that economics began to dictate sizable reductions in the amount of infiltration allowable for newly installed sanitary sewers.

To insure quality sewer pipe materials and proper installation practices, engineers began to use specifications that limited the amount of water leakage a sewer could have after being installed. Allowable leakage rates were typically specified as gallons of water per inch of diameter per mile of sewer per day. A survey conducted in the middle 1950's on sewer infiltration allowances specified by consulting engineers indicated rates as high as 1,000 gallons per inch of diameter per mile per day and disclosed that some municipalities and sewer districts permitted as high as 1,500 gallons per inch of diameter per mile of pipe per day. Such excessive allowances were replaced in the 1960's by allowances in the neighborhood of 500 gallons per inch of diameter per mile per day. In the late 1960's and early 1970's, the trend continued to minimize costly infiltration through the use of higher quality pipe materials and better elastomeric joint seals. By this time, infiltration rates of 200 gallons per inch of diameter per mile per day were quite common.

Today the costs of wastewater treatment and collection are such that even 200 gallons per inch of diameter per mile per day can be considered excessive from a cost-effective point of view. The stringent sewage treatment requirements mandated by the "Water Pollution Control Act of 1972" and the more recent "Clean Water Act of 1977" have renewed the public's awareness of the high costs associated with sewage treatment. Specifying lower allowable infiltration rates can minimize these costs. Consequently, an ever increasing number of consulting engineers and regulatory bodies are now specifying maximum infiltration rates ranging from 50 to 150 gallons per inch of diameter per mile per day. Such rates are obtainable in properly installed, modern sewer piping systems.

Infiltration testing is accurate and representative only when the pipe is continuously under groundwater. However, many sewers are only seasonally under groundwater and others are exposed to infiltration only during rain events. To test in these situations a water exfiltration test was developed. This test was a logical extension of the infiltration test. The controllable conditions under which the exfiltration test could be performed had obvious advantages. But, the exfiltration test is not without its own shortcomings, the most notable being air entrainment. Unless every lateral is provided with an air vent, air is likely to be trapped in the line as it is filled with water. If this is the case, there is no way of knowing how much of the volume
lost during the test is due to water leakage and how much is the result of trapped air loss.

Since air had complicated testing with water, engineers began testing with air alone. During the past 20 years, low-pressure air testing has become a fully accepted means of testing sewers. The vast majority of users now believe low-pressure air testing to be far superior to any other.

It is true that due to the differing physical characteristics of water and air, no direct numerical correlation exists between air loss and water leakage. However, the lack of a numerical correlation does not mean that the two are unrelated. An experience article entitled, "Air Testing Sanitary Sewers," by Sam H. Hobbs and Lloyd G. Cherne, published in the April, 1968, WPCF Journal, established that lower air loss rates are associated with lower water leakage rates. In this regard, allowable air loss rates have evolved over the years in a manner not unlike allowable leakage rates, i.e., allowable air loss rates have decreased over the years.

The most notable and respected researchers on the subject of low-pressure air testing are Messrs. Ramseier and Riek who first published an article in the Journal of the Sanitary Engineering Division, A.S.C.E., April 1964, entitled, "Low Pressure Air Test for Sanitary Sewers." Based upon a thorough analysis of collected data from 515 air tests they concluded that: "The recommended specifications consider the pipeline installation acceptable if it loses air at a rate not greater than 0.0030 cubic foot per minute per square foot of internal pipe surface when tested at an average pressure of 3.0 psi greater than the average back pressure of any ground water that may submerge the pipe. When any section of the installation, tested in its entirety between manholes or cleanout structures, loses air at a rate greater than 0.0030 cu.ft. per min. per sq.ft. of internal pipe surface, but the total rate of air loss from the section under test does not exceed 2.0 cu.ft. per min., the pipeline shall be considered free from significant leaks. When these rates of leakage are exceeded, pipe breakage, joint leakage or plug leakage will be present, and appropriate repairs should be made." Thus, most early air test specifications required that allowable air loss not exceed either the total rate of 2.0 cu.ft. per minute or the per square foot rate of 0.0030 cu.ft. per minute, whichever was greater for the section being tested. The only justification for the 2.0 cu.ft. per minute allowance was the inability of equipment used in the beginning of the 1960's to locate leaks smaller than 2 cu.ft. per minute.

After the early 1960's, significant progress was made. Equipment capable of finding leaks much smaller than 1 cu.ft. per minute was developed. Thus, many parts of the country eliminated the 2.0 cu.ft. per minute minimum, simplifying the test considerably and providing added assurance of quality installation.

Mr. Ramseier pursued his interest in proper air test requirements and continued to collect data and analyze the results to determine if actual air loss had decreased over the years in conjunction with the more stringent infiltration limits. Mr. Ramseier published his findings in the April, 1972, issue of the Water Pollution Control Federation Journal. His article, entitled "Testing New Sewer Pipe Installations," summarized the results from over 1,100 tests made on newly installed sewers. Ramseier noted that pipe tested before 1962 had a greater pipe wall and pipe joint porosity than pipe tested since that time and that the decrease in porosity coincided with the general adoption of air testing. Ramseier also reported that, "specifications recommended in 1963 were based on more
porous pipe that had been under observation for several years and an average loss of 0.003 cu.ft. of air/min./sq.ft. of internal pipe surface was chosen as the basis of the specifications." However, through continued analysis of actual test results, Ramseier found out of all pipes tested that "85 percent leaked less than 0.0015 cu.ft./min./sq.ft.," this rate of air loss being only half of that originally used. In fact, several regulatory bodies began writing specifications based on 0.0015 cu.ft./min./sq.ft. in the mid 1960's and have been very satisfied with the results. Thus, Ramseier concluded that "0.0015 can be used in an area where the pipe manufacturers and contractors have accepted air testing."

Even more important than the observed reduction in air loss rate per unit of pipe surface area was Ramseier's finding relative to a recommended maximum total leakage rate, regardless of pipe size or length. Ramseier found that a maximum total leakage rate is essential to eliminate the possibility of one or two significant leaks in an otherwise good section of pipe.

To determine a reasonable specification limit, Ramseier again analyzed the actual air test data he had collected. He found that "94 percent of the pipes tested had a loss of less than 2 cu.ft./min. and 87 percent had a loss of less than 1 cu.ft./min."

From his extensive analysis, Mr. Ramseier concluded that:

"A specification based only on the average loss per unit of surface area can be uniformly applied to all sections having an area less than 625 sq.ft. internal surface, but as the surface area of the pipe increases, the possibility of the one undetected leak in an otherwise perfect pipe increases. A specification based only on the total loss will, in turn, allow a high average loss for short sections."

To accommodate this conclusion, Mr. Ramseier developed the following recommended air test specification:

"Test sections shall not lose more than Q cubic feet per minute per square foot of internal surface area for any portion containing less than 625 square feet internal surface area. The total leakage from any test section shall not exceed 625 Q cu.ft./min."

The Uni-Bell PVC Pipe Association's, "Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe," is based upon and supports the thoroughly researched recommended air test specification of Mr. Roy Edwin Ramseier.

Considering more than 20 years of documented air testing history, the steadily increasing cost of sewage treatment, the higher sewer maintenance costs associated with poor quality construction and the fact that nearly every region of North America has accepted air testing; an allowable leakage rate of 0.0015 cu.ft./min./sq.ft. would appear to be long overdue. Thus, a maximum Q value of 0.0015 cu.ft./min./sq.ft. is strongly recommended. Such a Q value yields a maximum total leakage rate of about 1.0 cu.ft./min. (625 Q).

To corroborate Ramseier's findings, William Chase and Walter Berschauer published an analysis of their air test results in the May and June, 1972, issues of Public Works Magazine. They found that "Comparing Mr. Ramseier's data with the authors' indicates a remarkable similarity in the performance of all three types of pipe in the range of the usual specifications." The plotted data of Chase and Berschauer indicates that 70 percent of the pipes tested in the late 1960's and very early 1970's leaked less than 0.0015 cu.ft./min./sq.ft. These results were based upon over 1,300
tests of some 380,000 lineal feet of pipe ranging in sizes from 6" through 24".

Low-pressure air testing is economical to run and the equipment can be operated quickly and easily. Consequently, contractors are able to test each section of pipe rather than random testing. Therefore, a much tighter pipe can be turned over to the owner. Everyone benefits from specified air test requirements that are properly enforced. It may require that extra care be taken during installation, but the results are good for everyone, e.g., the engineer's reputation, the contractor's pride and the community's pocketbook.

It is important to remember in judging the original acceptability of any sewer: the sewer is in its best condition at the time of acceptance. In other words, the specified infiltration rate or air loss rate will tend to increase over the years. Thus, it behooves design engineers and conscientious communities to insist upon an efficient test that will assure the best possible initial condition. The data compiled by Messrs. Ramseier, Chase, Berschauer and others clearly shows that, for many years, the vast majority of properly installed sewer pipe could pass an air test limit of 0.0015 cu.ft./min./sq.ft. Thus, only an air test limit less than or equal to 0.0015 cu.ft./min./sq.ft. will assure the best possible initial condition and quality workmanship for today's modern sewer collection systems.

SECTION 1 - SCOPE

1.1 This recommended practice defines the proper procedures for acceptance testing of installed gravity sewer pipe, using low-pressure air, to provide assurance that the pipe, as installed, is free from significant leaks. Included are requirements for equipment accuracy, safety precautions, line preparation, test method and minimum holding times. This recommended practice does not cover the testing of manholes.

1.2 Only lines tested after backfilling to final grade will be considered for acceptability. However, this test may also be used by the installer as a presumptive test to determine the condition of the line prior to backfilling.

SECTION 2 - DEFINITIONS

2.1 Owner: The person, firm, corporation or government subdivision entering into contract with the Contractor for the installation of sewer pipe and appurtenances.

2.2 Engineer: The person, firm, corporation or government agency acting for the Owner as his duly authorized agent in designing and engineering the project.

2.3 Inspector: An authorized representative of the Engineer or Owner assigned to make any and all necessary inspections of the work performed, materials and equipment furnished by the Contractor.

2.4 Contractor: The person, firm or corporation entering into the contract with the Owner for the installation of sewer pipe and appurtenances.

2.5 Other Terms: Whenever in the specifications or drawings the words directed, required, permitted, ordered, designated, prescribed or words of like import are used, it shall be understood that a direction, requirement, permission, order, designation or prescription of the Engineer is intended, and similarly, the words approved, acceptable, satisfactory or words of like import shall mean approved by, or acceptable or satisfactory to, the Engineer, unless otherwise expressly stated.
SECTION 3 - RESPONSIBILITIES

3.1 RESPONSIBILITY OF THE CONTRACTOR
Unless otherwise specified, the Contractor shall furnish all the necessary equipment and be responsible for conducting all low-pressure air tests. In addition, the Contractor is responsible for any necessary repair work on sections that do not pass the test. No sealant shall be used in any newly installed sewer without the prior approval of the Engineer. Using sealant in a sewer is not the equivalent of a sound sewer pipe. Proper structural repair work is much preferred and may be required by the Engineer or the Owner.

3.2 RESPONSIBILITY OF THE ENGINEER
The Engineer and/or a qualified Inspector shall witness all low-pressure air tests and verify the accuracy and acceptability of the equipment utilized. The Engineer should inform the Contractor regarding acceptable methods of repair in the event one or more sections fail to pass the low-pressure air test. The Engineer should also report to the Owner regarding the acceptability of the Contractor’s work.

3.3 RESPONSIBILITY OF THE OWNER
The Owner shall make a final decision as to the acceptability of the Contractor’s work based upon the Engineer’s recommendation.

3.4 REGULATORY AGENCIES
Regulatory Agencies at the State, Federal and/or local level may be legally entitled to witness any air testing and/or review the results. The Owner or his Engineer should check to see that the low-pressure air test specified for his installation is at least as stringent as those that may be required by such regulatory bodies.

SECTION 4 - SAFETY

4.1 PLUG RESTRAINT
It is extremely important and essential that all plugs be installed and braced in such a way that blowouts are prevented. As an example of the hazard, a force of 250 pounds is exerted on an 8-inch plug by an internal pipe pressure of 5 psig, and a force of 2,250 pounds is exerted on a 24-inch plug by an internal pressure of 5 psig. It must be realized that sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be very dangerous. For this reason it is recommended that every plug be positively braced against the manhole walls, and that no one be allowed in the manhole adjoining a line being tested so long as pressure is maintained in the line.

It is further recommended that no internal pressure of more than 9 psig be permitted except for leak location equipment where the plugs are firmly tied together.

4.2 RELIEF VALVE
All pressurizing equipment used for low-pressure air testing shall include a regulator or relief valve set no higher than 9 psig to avoid over-pressurizing and displacing temporary or permanent plugs. As an added safety precaution, the pressure in the test section should be continuously monitored to make certain that it does not at any time exceed 9 psig. (It may be necessary to apply higher pressure at the control panel to overcome friction in the air supply hose during pressurization.)

SECTION 5 - EQUIPMENT

5.1 PLUG DESIGN
Either mechanical or pneumatic plugs may be used. All plugs shall be designed to resist internal testing pressures without the aid of external bracing or blocking. However, the
Contractor should internally restrain or externally brace the plugs to the manhole wall as an added safety precaution throughout the test.

5.2 SINGULAR CONTROL PANEL
To facilitate test verification by the inspecting Engineer, all air used shall pass through a single, above ground control panel.

5.3 EQUIPMENT CONTROLS
The above ground air control equipment shall include a shut-off valve, pressure regulating valve, pressure relief valve, input pressure gauge and a continuous monitoring pressure gauge having a pressure range from 0 to at least 10 psi. The continuous monitoring gauge shall be no less than 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of ±0.04 psi.

5.4 SEPARATE HOSES
Two separate hoses shall be used to: (1) connect the control panel to the sealed line for introducing low-pressure air, and (2) a separate hose connection for constant monitoring of air pressure build-up in the line. This requirement greatly diminishes any chance for over-pressurizing the line.

5.5 PNEUMATIC PLUGS
If pneumatic plugs are utilized, a separate hose shall also be required to inflate the pneumatic plugs from the above ground control panel.

SECTION 6
LINE PREPARATION

6.1 LATERALS, STUBS AND FITTINGS
During sewer construction all service laterals, stubs and fittings into the sewer test section shall be properly capped or plugged so as not to allow for air loss that could cause an erroneous air test result. It may be necessary and is always advisable to restrain gasketed caps, plugs or short pipe lengths with bracing stakes, clamps and tie-rods or wire harnesses over the pipe bells.

6.2 PIPE WETTING
Air may pass through some porous pipe materials. If such materials are used, the pipe walls may be wetted to temporarily reduce the porosity of the material. Non-porous pipe materials need not be wetted. Note - Ramseier found that wetting the pipe would reduce its air loss rate by 96 percent.

SECTION 7 - TEST PROCEDURE

7.1 PLUG INSTALLATION AND TESTING
After a manhole-to-manhole reach of pipe has been backfilled to final grade, prepared for testing and the specified waiting period has elapsed, the plugs shall be placed in the line at each manhole and secured.

It is advisable to seal test all plugs before use. Seal testing may be accomplished by laying one length of pipe on the ground and sealing it at both ends with the plugs to be checked. The sealed pipe should be pressurized to 9 psig. The plugs shall hold against this pressure without bracing and without any movement of the plugs out of the pipe. No persons shall be allowed in the alignment of the pipe during plug testing.

It is advisable to plug the upstream end of the line first to prevent any upstream water from collecting in the test line. This is particularly important in high groundwater situations.

When plugs are being placed, the pipe adjacent to the manhole shall be visually inspected to detect any evidence of shear in the pipe due to differential settlement between the pipe and the manhole. A probable point of leakage is at the junction of the manhole and the pipe, and this fault may be covered by the pipe plug, and thus not revealed by the air test.
7.2 LINE PRESSURIZATION
Low pressure air shall be slowly introduced into the sealed line until the internal air pressure reaches 4.0 psig greater than the average back pressure of any groundwater above the pipe, but not greater than 9.0 psig. If groundwater is present, refer to Section 8 - "Determination of Ground Water Elevation and Air Pressure Adjustment."

7.3 PRESSURE STABILIZATION
After a constant pressure of 4.0 psig (greater than the average groundwater back pressure) is reached, the air supply shall be throttled to maintain that internal pressure for at least 2 minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe wall.

7.4 TIMING PRESSURE LOSS
When temperatures have been equalized and the pressure stabilized at 4.0 psig (greater than the average groundwater back pressure), the air hose from the control panel to the air supply shall be shut off or disconnected. The continuous monitoring pressure gauge shall then be observed while the pressure is decreased to no less than 3.5 psig (greater than the average back pressure of any groundwater over the pipe). At a reading of 3.5 psig, or any convenient observed pressure reading between 3.5 psig and 4.0 psig (greater than the average groundwater back pressure), timing shall commence with a stop watch or other timing device that is at least 99.8 percent accurate.

A predetermined required time for a specified pressure drop shall be used to determine the lines acceptability. Traditionally, a pressure drop of 1.0 psig has been specified. However, other pressure drop values may be specified, provided that the required holding times are adjusted accordingly. If the specified pressure drop is 0.5 psig rather than the more traditional 1.0 psig, then the required test times for a 1.0 psig pressure drop must be halved.

Specifying a 0.5 psig pressure drop is desirable in that it can reduce the time needed to accomplish the air test without sacrificing test integrity. Therefore, the following subsections contain provisions for both the traditional 1.0 psig pressure drop and the more efficient 0.5 psig pressure drop. All requirements for a specified 0.5 psig drop are given in parentheses. To provide further efficiencies in testing, there is a zero pressure drop option. If there has been no leakage (zero psig drop) after one hour of testing, the test section shall be accepted and the test complete.

7.5 DETERMINATION OF LINE ACCEPTANCE
7.5.1 If the time shown in Table I (or Table II), for the designated pipe size and length, elapses before the air pressure drops 1.0 psig (or 0.5 psig); the section undergoing test shall have passed and shall be presumed to be free of defects. The test may be discontinued once the prescribed time has elapsed even though the 1.0 psig (or 0.5 psig) drop has not occurred.

7.5.2 If there has been no leakage (zero psig drop) after one hour of testing, the section undergoing test shall have passed and shall be presumed free of defects. If there has been any pressure drop, the test shall continue as specified in 7.5.1.

7.6 DETERMINATION OF LINE FAILURE
If the pressure drops 1.0 psig (or 0.5 psig) before the appropriate time shown in Table I (or Table II) has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test.

7.7 LINE REPAIR OR REPLACEMENT
If the section fails to meet these requirements, the Contractor shall determine at his own expense the source, or sources, of leakage, and he shall repair or replace all defective materials and/or workmanship to the satisfaction of the Engineer. The extent
and type of repair which may be allowed, as well as results, shall be subject to the approval of the Engineer. The completed pipe installation shall then be retested and required to meet the requirements of this test.

SECTION 8
DETERMINATION OF GROUNDWATER ELEVATION AND AIR PRESSURE ADJUSTMENT

8.1 APPLICABILITY
The requirements of this Section shall only apply where groundwater is known to exist or is anticipated above the sewer line to be tested.

8.2 PIPE NIPPLE INSTALLATION
During manhole installation, a one-half inch diameter threaded pipe nipple shall be installed through the manhole wall directly on top of one of the sewer pipes entering the manhole. The threaded end of the nipple shall extend no more than two inches on the inside of the manhole. The total length of the nipple shall exceed the manhole wall thickness by no less than four inches. The pipe nipple shall be non-corrosive and resistant to chemicals common in domestic sewage. Special attention shall be given to providing a permanent, watertight seal around the pipe nipple at the manhole wall. The pipe nipple shall be sealed with a threaded one-half inch cap. Every manhole need not have a pipe nipple. A few key manhole locations should be sufficient to establish a groundwater profile for the test area. The Engineer shall assist the Contractor in selecting appropriate manholes for pipe nipple installation.

8.3 GROUNDWATER ELEVATION
Immediately before air testing, the groundwater level shall be determined by removing the threaded cap(s) from the nipple(s) nearest the section to be tested, blowing air through the pipe nipple(s) to remove any obstructions, and then connecting clear plastic tube(s) to the pipe nipple(s). Each plastic tube shall be held vertically to allow groundwater to rise in it. After the water level in the tube has stopped rising, a measurement of the height in feet of water over the invert of the sewer pipe shall be taken. (See Figure 1.) If the section to be tested is not immediately adjacent to an installed pipe nipple, the groundwater height shall be estimated based upon nearby height readings and the pipe's invert elevation.

8.4 AIR PRESSURE ADJUSTMENT
The air pressure correction, which must be added to the 3.5 psig normal test starting pressure, shall be calculated by dividing the average vertical height, in feet of groundwater above the invert of the sewer pipe to be tested by 2.31. The result gives the air pressure correction in pounds per square inch to be added. (For example, if the average vertical height of groundwater above the pipe invert is 2.8 feet, the additional air pressure required would equal 2.8 divided by 2.31 or 1.2 psig. This would require a minimum starting pressure of 3.5 plus 1.2 or 4.7 psig.) The allowable pressure drop of 1.0 psig (or 0.5 psig) and the timing in Table I (or Table II) are not affected and shall remain the same.

8.5 MAXIMUM TEST PRESSURE
In no case should the starting test pressure exceed 9.0 psig. If the average vertical height of groundwater above the pipe invert is more than 12.7 feet, the section so submerged may be tested using 9.0 psig as the starting test pressure. The 9 psig limit is intended to further ensure workman safety and falls within the range of the pressure monitoring gauges normally used.

8.6 RE-SEALING OF PIPE NIPPLES
After the groundwater height has been determined, each pipe nipple shall be
FIGURE NO. 1

MANHOLD CROSS-SECTIONAL VIEW
OF THE PROPER METHOD FOR
DETERMINING GROUND WATER HEIGHT

Temporary Clear Plastic Tubing
Connected to ½" pipe after it has
been blown clear. Tube is held
vertically and height of water
measured from pipe invert.

Ground Water
Level

Height
of
Ground
Water
in Feet

Permanent
Water-
Tight
Seal

Permanent
Cap
(Removable)

½" Diameter Non-Corrosive
Pipe, Installed at time of
manhole installation

Sewer Line to
be Air Tested
recapped and sealed to prevent any future infiltration.

SECTION 9 - TEST TIMES

9.1 TEST TIME CRITERIA
The Ramseier test time criteria requires that no test section shall be accepted if it loses more than $Q$ cubic feet per minute per square foot of internal pipe surface area for any portion containing less than 625 square feet internal pipe surface area. The total leakage from any test section shall not exceed 625 $Q$ cubic feet per minute.

9.2 ALLOWABLE AIR LOSS RATE
A $Q$ value of 0.0015 cubic feet per minute per square foot shall be utilized to assure the Owner of quality pipe materials, good workmanship and tight joints.

9.3 TEST TIME CALCULATION
All test times shall be calculated using Ramseier's equation:

$$ T = 0.085 \frac{DK}{Q} $$

Where: $T =$ Shortest time, in seconds, allowed for the air pressure to drop 1.0 psig,

$D =$ 0.000419 DL, but not less than 1.0,

$Q =$ 0.0015 cubic feet/minute/square feet of internal surface,

$K =$ Nominal pipe diameter in inches, and

$L =$ Length of pipe being tested in feet.

For more efficient testing of long test sections and/or sections of larger diameter pipes, a timed pressure drop of 0.5 psig may be used in lieu of the 1.0 psig timed pressure drop. If a 0.5 psig pressure drop is used, the appropriate required test times shall be exactly half as long as those obtained using Ramseier's equation for $T$ cited above.

If there has been no leakage (zero psig drop) after one hour of testing, the test section shall be accepted and the test complete. This provides a more efficient test for large diameter sewers that have demonstrated an air loss rate (zero) well within the allowable. If there is any pressure drop, the complete test shall be run to determine whether or not the test section is acceptable.

9.4 TESTING MAIN SEWERS WITH LATERAL SEWERS
It is often convenient to include connected lateral sewers when testing sewer mains having lateral sewers. If lateral sewers are included in the test, their lengths may generally be ignored for computing required test times. This can be done because in practice, ignoring the branch, lateral or house sewers will normally increase the severity of the air test whenever the tested surface area is less than 625 square feet so that the total rate of rejection may only be increased about 2 percent. If the total tested surface area is greater than 625 square feet, ignoring the lateral sewers will only slightly decrease the severity of the test.

In the event a test section, having a total internal surface area less than 625 square feet, fails to pass the air test when lateral sewers have been ignored; the test time shall be recomputed to include all lateral sewers using the following formula:

$$ T = 0.085 \left[ \frac{D_1^1 L_1 + D_2^2 L_2 + \ldots + D_n^2 L_n}{D_1^1 L_1 + D_2^2 L_2 + \ldots + D_n^2 L_n} \right] \frac{K}{Q} $$

Where: $T =$ Shortest time, in seconds, allowed for the air pressure to drop 1.0 psig.
K = 0.000419 (D_1 L_1 + D_2 L_2 + \ldots + D_n L_n), but not less than 1.0;

Q = 0.0015 cu.ft./min./sq.ft. of internal surface;

D_1, D_2, etc. = Nominal diameters of the different size pipes being tested;

L_1, L_2, etc. = Respective lengths of the different size pipes being tested.

If the recomputed test time is short enough to allow the section tested to pass, then the section shall be presumed to be free of defects and comply with this specification.

9.5 SPECIFIED TIME TABLES

To facilitate the proper use of this recommended practice for air testing, the following tables are provided. Table I contains the specified minimum times required for a 1.0 psig pressure drop from a starting pressure of at least 3.5 psig greater than the average back pressure of any groundwater above the pipe's invert. Table II contains specified minimum times required for a 0.5 psig pressure drop from a starting pressure of at least 3.5 psig greater than the average back pressure of any groundwater above the pipe's invert. Both tables also include easy to use formulas for calculating required test times for various pipe sizes and odd lengths. Also, a zero pressure drop option is shown as a footnote to Table I and Table II. If there has been no leakage (zero psig drop) after one hour, the test section is accepted and the test is complete. A series of examples are provided in the Appendix to this recommended practice that demonstrates proper use of the tables.
TABLE I

MINIMUM SPECIFIED TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015

<table>
<thead>
<tr>
<th>1 Pipe Diameter (in.)</th>
<th>2 Minimum Time (min: sec)</th>
<th>3 Length for Minimum Time (ft)</th>
<th>4 Time for Longer Time (sec)</th>
<th>Specification Time for Length (L) Shown (min: sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 ft</td>
</tr>
<tr>
<td>8</td>
<td>7:34</td>
<td>597</td>
<td>1.520 L</td>
<td>7:34</td>
</tr>
<tr>
<td>18</td>
<td>17:00</td>
<td>597</td>
<td>7.692 L</td>
<td>17:00</td>
</tr>
</tbody>
</table>

Note: If there has been no leakage (zero psig drop) after one hour of testing, the test section shall be accepted and the test completed. (See Section 7.5.)
### TABLE II

MINIMUM SPECIFIED TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015

<table>
<thead>
<tr>
<th>1 Pipe Diameter (in.)</th>
<th>2 Minimum Time (min: sec)</th>
<th>3 Length for Minimum Time (ft)</th>
<th>4 Time for Longer Length (sec)</th>
<th>Specification Time for Length (L) Shown (min:sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1:53</td>
<td>597</td>
<td>.190 L</td>
<td>1:53</td>
</tr>
<tr>
<td>6</td>
<td>2:50</td>
<td>398</td>
<td>.427 L</td>
<td>2:50</td>
</tr>
<tr>
<td>8</td>
<td>3:47</td>
<td>298</td>
<td>.760 L</td>
<td>3:47</td>
</tr>
<tr>
<td>10</td>
<td>4:43</td>
<td>239</td>
<td>1.187 L</td>
<td>4:43</td>
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<tr>
<td>12</td>
<td>5:40</td>
<td>199</td>
<td>1.709 L</td>
<td>5:40</td>
</tr>
<tr>
<td>15</td>
<td>7:05</td>
<td>159</td>
<td>2.671 L</td>
<td>7:05</td>
</tr>
<tr>
<td>18</td>
<td>8:30</td>
<td>133</td>
<td>3.846 L</td>
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<td>21</td>
<td>9:55</td>
<td>114</td>
<td>5.235 L</td>
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</tr>
<tr>
<td>24</td>
<td>11:20</td>
<td>99</td>
<td>6.837 L</td>
<td>11:24</td>
</tr>
<tr>
<td>27</td>
<td>12:45</td>
<td>88</td>
<td>8.653 L</td>
<td>12:45</td>
</tr>
<tr>
<td>30</td>
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<td>80</td>
<td>10.683 L</td>
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<td>33</td>
<td>15:35</td>
<td>72</td>
<td>12.926 L</td>
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<td>36</td>
<td>17:00</td>
<td>66</td>
<td>15.384 L</td>
<td>17:00</td>
</tr>
<tr>
<td>42</td>
<td>19:54</td>
<td>57</td>
<td>20.942 L</td>
<td>19:54</td>
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<td>48</td>
<td>22:47</td>
<td>50</td>
<td>27.352 L</td>
<td>22:47</td>
</tr>
<tr>
<td>54</td>
<td>25:31</td>
<td>44</td>
<td>34.618 L</td>
<td>25:31</td>
</tr>
<tr>
<td>60</td>
<td>28:20</td>
<td>40</td>
<td>42.738 L</td>
<td>28:20</td>
</tr>
</tbody>
</table>

Note: If there has been no leakage (zero psig drop) after one hour of testing, the test section shall be accepted and the test complete. (See Section 7.5.)
APPENDIX 1

10.1 PURPOSE

The purpose of this Appendix is to illustrate the proper application of this recommended practice with regard to appropriate test time selection. The examples that follow include a variety of conditions that may be encountered in the field.

10.2 EXAMPLE A

A manhole-to-manhole reach of nominal 12 inch pipe is 350 feet long. No lateral connections exist in the reach. What is the required test time for a 0.5 psig pressure drop?

Solution: The required test time can be read directly from Table II. For 350 feet of 12 inch pipe, the required test time is 9:58 (9 minutes and 58 seconds).

10.3 EXAMPLE B

A 350 foot section of nominal 12 inch pipe is ready for testing. A total of 128 feet of 4 inch lateral sewer pipe is connected to the 350 foot section and will be included in the test. What will be the required test time for a 0.5 psig pressure drop?

Solution: Lateral sewers may be disregarded when selecting test times (see Section 9.4). Therefore, the required test time will be the same as for Example A, i.e., 9 minutes and 58 seconds.

Note - If lateral sewers had not been disregarded, the required test time would be 10 minutes and 22 seconds, i.e., only 24 seconds longer.

10.4 EXAMPLE C

What should the required test time be for a 1.0 psig pressure drop in 327 feet of nominal 8 inch diameter pipe between two manholes?

Solution: The exact test time is easily calculated by using Table I. Table I is used because a 1.0 psig pressure drop is specified. Since 327 feet exceeds the 298 foot length associated with the minimum test time for an 8 inch pipeline, the fourth column in Table I shall be used to quickly calculate the required test time as follows:

\[ T = 1.520 \times L = 1.52 \times 327 = 497 \text{ seconds} \]

Therefore, the required test time for a 1.0 psig pressure drop is 497 seconds or 8 minutes and 17 seconds.

10.5 EXAMPLE D

A manhole-to-manhole reach of nominal 24 inch pipe is 82 feet long. What is the required test time for a 0.5 psig pressure drop?

Solution: Table II must be used because a 0.5 psig pressure drop is specified. Since 82 feet is less than the 99 foot length associated with the minimum test time for a 24 inch pipeline, the minimum test time shall apply. Thus, the required test time for a 0.5 psig pressure drop must be 11:20 (11 minutes and 20 seconds).

10.6 EXAMPLE E

A 412 foot section of nominal 15 inch sewer pipe has been readied for air testing. A total of 375 feet of nominal 6 inch lateral piping and 148 feet of nominal 4 inch lateral piping branch off of the 15 inch sewer line. All laterals have been capped and/or plugged and will be tested together with the 15 inch main line. The specified pressure drop that will be timed is 0.5 psig. What is the appropriate test time for this pipe network?

Solution: All lateral sewer sizes and lengths may be disregarded since their influence is generally not significant enough to warrant computation (refer to Section 9.4). Table II must be used for a 0.5 psig pressure drop. The fourth column in the table provides the appropriate formula for calculating the required test time because 412 feet is longer than the third column value of 159 feet.

\[ T = 2.671 L = 2.671 \times 412 = 1,100 \text{ seconds} \]
The required test time is 1,100 seconds or 18 minutes and 20 seconds.

10.7 EXAMPLE F

A manhole-to-manhole reach of nominal 8 inch pipe is only 100 feet long. A total of 300 feet of nominal 4 inch lateral piping is connected to the 100 foot section and will be included in air testing the section. What will be the required test time for a 1.0 psig pressure drop?

Solution: The required test time can be read directly from Table I, since lateral sewers need not be considered. Thus, for 100 feet of 8 inch pipe, the required holding time is 7:34 (7 minutes and 34 seconds). However, should the section fail to meet this test, the required holding time must be recalculated taking into account the connected laterals per Section 9.4. This recalculation is required because the total internal pipe surface area is less than 625 square feet.

Total Area =

\[
\pi \left[ \frac{D_1L_1 + D_2L_2 + \ldots + D_nL_n}{12} \right]
\]

\[= 3.14 \left[ \frac{(8\times100) + (4\times300)}{12} \right]
\]

\[= 524 \text{ square feet}
\]

Thus, using the equation provided in Section 9.4, the required test time should be recomputed as follows:

\[K = 0.000419 \left[ (8 \times 100) + (4 \times 300) \right] = 0.838\]

\[0.838 < 1.0 \rightarrow K = 1.0\]

Note - K will always be 1.0 when the total area is less than 625 square feet.

\[T = 0.085 \left[ \frac{(8^2 \times 100) + (4^2 \times 300)}{(8 \times 100) + (4 \times 300)} \right] \frac{1.0}{0.0015}
\]

\[T = 317 \text{ seconds}
\]

The required test time is actually only 317 seconds or 5 minutes and 17 seconds for a 1.0 psig pressure drop. Therefore, if the section is able to meet this test time, it shall be passed.

Note - For a specified 0.5 psig pressure drop, the test holding time would be only half as long, i.e., 2 minutes and 38 seconds.
APPENDIX 2
AIR TEST DATA SHEET

Owner (Name of city, district, etc.) ___________________________ Test No. ______________

Identification of Pipe Installation (Job name, location, contract number, etc.) ___________________________

Field Test Data: (To be filled in by the Inspector)

Date: ______________ Specified Maximum Pressure Drop: ______________ psig

Identification of Pipe Material Installed ____________________________________________________________

<table>
<thead>
<tr>
<th>Pipe Under Test</th>
<th>Spec. Time</th>
<th>Field Test Operations Data</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Inspector's Name and Title: ________________________________________________________________

Signature of Inspector: ________________________________________________________________

If a section fails, the following items should be completed:

Identify section(s) that failed ____________________________________________________________

Leak (was) (was not) located. Method used: ______________________________________________

Description of leakage found: ___________________________________________________________

Description of corrective action taken: ___________________________________________________

For test results after repair refer to Test No. ______________. Inspector ________________________

This data sheet may be used in conjunction with Recommended Practice UNI-B-6. The Uni-Bell PVC Pipe Association is interested in evaluating the testing of sewer pipe installations with low-pressure air. The purpose of this "Air Test Data Sheet" is to assist in obtaining information from field testing of sewer pipes as well as to assist the community in evaluating the sewer's acceptability.

Copies of the above "Air Test Data Sheet" are available free of charge upon request from Uni-Bell. The Uni-Bell PVC Pipe Association suggests that one copy of the completed sheet be retained for your files and requests that one copy be sent to Uni-Bell PVC Pipe Association, 2655 Villa Creek Drive, Suite 155, Dallas, TX 75234.