

## VACUUM TESTING PRECAST CONCRETE MANHOLES

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Vacuum testing is a quick, safe and practical way to validate manhole system integrity. Manhole sections can be tested at the precast concrete plant prior to delivery or on site prior to backfilling. Following prescriptive guidelines in the ASTM Manual is essential for successful vacuum testing.

### When to vacuum test

Many codes and specifications require that a vacuum test be performed after the manhole has been installed and backfilled. Testing after backfilling provides a degree of certainty that a watertight system has been installed. The major disadvantage is the fact that no industry standards exist for vacuum testing after the structure has been backfilled. Secondly, it is often difficult to determine the cause of or locate and repair a system breach once the manhole has been backfilled.

The resolution to this problem is to perform a vacuum test prior to backfilling and, if necessary, again after backfilling.

### ASTM C1244

ASTM C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill, has been developed to govern the proper vacuum testing procedure for testing concrete manholes. ASTM C1244 clearly states that a vacuum test "is intended to be used as a preliminary test to enable the installer to demonstrate the condition of the concrete manhole prior to backfill."

When following the strict guidelines within ASTM C1244, a vacuum of 10 inches of mercury (10" Hg) is drawn on the manhole after all lift holes are plugged and pipes entering the manhole are temporarily plugged and securely braced. The time is measured for the vacuum to drop to 9" Hg. The manhole is acceptable if the measured time meets or exceeds the values presented in Table 1 of ASTM C1244. If the manhole fails the initial test, it may be repaired by an approved method until a satisfactory test is obtained.

Note: The latest edition of ASTM C1244 should be used for proper testing procedures and criteria.

### Vacuum testing in the presence of ground water

Vacuum testing after backfilling should be performed only after a successful nonbackfill test has been completed in accordance with ASTM C1244.

Many people do not fully understand the effects of vacuum testing backfilled manhole systems in the presence of ground water. Vacuum testing backfilled manhole systems is not recommended, especially in the presence of ground water. Vacuum testing a manhole system that is already subjected to hydrostatic pressure may exceed the design limits of critical flexible connectors, leading to a system failure.

If ground water is present, use the following information to determine if a reduction in vacuum pressure is warranted:

Note: For simplicity, the effects of soil pressure are not taken into account in the following information and examples. In the field, the in-place loads may be greater when in-place soil conditions (effective stress) are taken into consideration. To determine the actual loads induced on a backfilled structure, use the following information in addition to the actual in-place soil properties to properly calculate the effective stress at the critical location.

1. Depth to water table (see sidebar "[Stand Pipes](#)")
2. Pressure rating for flexible connector (see sidebar "[Pressure Ratings](#)")
3. Depth to bottom-most critical connector

With this information, you can determine that the theoretical in-place loads experienced by the deepest connector as outlined in the following example. If the combined pressure differential (vacuum and hydrostatic) between the interior and exterior of the manhole exceeds the connector's pressure rating, appropriate adjustments must be made.

XYZ County specifications require that all manhole systems be vacuum tested in accordance with ASTM C1244 requirements after backfilling.

Manhole Diameter: 48 inches

Manhole Depth: 30 feet

Depth to Water Table: 8 feet

Acceptance Test: ASTM C1244\*

Resilient Connector: ASTM C923\*\*

Depth to Connector: 28 feet

\* ASTM C1244 requires a vacuum between 10" Hg and 9" Hg (-5 psig to

-4.5 psig) be maintained for 74 seconds.

\*\* ASTM C923 requires resilient connectors to withstand a hydrostatic pressure of 13 psig when installed in a straight alignment and 10 psig when axial deflected 7 degrees.

External Pressure at Critical Depth (Hydrostatic pressure)

$$\left[ \left( 62.4 \frac{\text{lbs}}{\text{ft}^3} \right) * (28 \text{ ft} - 8 \text{ ft}) \right] * \frac{1 \text{ ft}^2}{(12 \text{ in})^2} = 8.67 \frac{\text{lbs}}{\text{in}^2}$$

or

$$0.433 \frac{\text{psi}}{\text{ft}_{\text{head}}} * (28 \text{ ft} - 8 \text{ ft}) = 8.66 \text{ psi}_{\text{Hydrostatic}}$$

Internal Pressure at Critical Depth (Vacuum pressure)

$$10 \text{ in Hg} * 0.5 \frac{\text{psi}}{\text{in Hg}} = 5 \text{ psi} \approx -5 \text{ psi}_{\text{Internal}}$$

Does the Pressure Differential Exceed the ASTM C923 Pressure Rating?

$$8.66 \text{ psi}_{\text{External}} - (-5 \text{ psi}_{\text{Internal}}) = 13.66 \text{ psi} > \text{The ASTM pressure rating (13 psi)}$$

The combined vacuum test and in-place hydrostatic loads exceed the connector's pressure rating, so appropriate adjustments must be made.

Adjusting vacuum pressure

Most flexible connectors have a pressure rating of only 10 psi when deflected, which is fairly common in a field installation; therefore we will use the more conservative 10 psi pressure rating as a base point. Drawing a vacuum of 10" Hg creates a pressure differential of 5 psi between the interior and exterior of a manhole system. A water column of 11.5 feet creates an additional 5 psi of external pressure. This ultimately creates a pressure differential of 10 psi at a connector located 11.5 feet under water when drawing a vacuum of 10" Hg.

A conservative rule of thumb is to reduce the vacuum by 1" Hg for every 1 foot of hydrostatic head between 12 feet and 21 feet. A vacuum test should not be performed when the hydrostatic head exceeds 22 feet.

Hydrostatic Head (ft)*	12	13	14	15	16	17	18	19	20	21	22
Vacuum Pressure (in inches Hg)	10	9	8	7	6	5	4	3	2	1	**

\*Hydrostatic head above critical connector

\*\*At 22 feet below the groundwater table, the connector is naturally subjected to 9.5 psi

Using the recommendation above, the testing agency should draw only 2" Hg to prevent overloading the flexible connecto.

External Pressure at Critical Depth (Hydrostatic pressure)

$$0.433 \frac{\text{psi}}{\text{ft}_{\text{head}}} * (28 \text{ ft} - 8 \text{ ft}) = 8.66 \text{ psi}_{\text{Hydrostatic}}$$

Internal Pressure at Critical Depth (Adjusted Vacuum pressure)

$$2 \text{ in Hg} * 0.5 \frac{\text{psi}}{\text{inHg}} = 1 \text{ psi} \approx -1 \text{ psi}_{\text{internal}}$$

$$8.67 \text{ psi}_{\text{External}} - (-1 \text{ psi}_{\text{internal}}) = 9.67 \text{ psi} < \text{The conservative ASTM pressure rating (10 psi)}$$

For more information on precast concrete manholes, please contact NPCA at (800) 366-7731 or visit [www.precast.org](http://www.precast.org).

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