



# Standard Specification for Precast Concrete Septic Tanks<sup>1</sup>

This standard is issued under the fixed designation C 1227; 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.

## 1. Scope

1.1 This specification covers design requirements, manufacturing practices, and performance requirements for monolithic or sectional precast concrete septic tanks.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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:<sup>2</sup>

- A 82/A 82M Specification for Steel Wire, Plain, for Concrete Reinforcement
- A 185/A 185M Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
- A 496/A 496M Specification for Steel Wire, Deformed, for Concrete Reinforcement
- A 497/A 497M Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
- A 615/A 615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- A 706/A 706M Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
- A 996/A 996M Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
- C 33 Specification for Concrete Aggregates
- C 39/C 39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
- C 94/C 94M Specification for Ready-Mixed Concrete
- C 125 Terminology Relating to Concrete and Concrete Aggregates

- C 150 Specification for Portland Cement
  - C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
  - C 260 Specification for Air-Entraining Admixtures for Concrete
  - C 330 Specification for Lightweight Aggregates for Structural Concrete
  - C 494/C 494M Specification for Chemical Admixtures for Concrete
  - C 595 Specification for Blended Hydraulic Cements
  - C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
  - C 685/C 685M Specification for Concrete Made by Volumetric Batching and Continuous Mixing
  - C 890 Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
  - C 990 Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
  - C 1116/C 1116M Specification for Fiber-Reinforced Concrete
- ### 2.2 ACI Standard:<sup>3</sup>
- ACI 318 Building Code Requirements for Reinforced Concrete
- ### 2.3 NSF/ANSI Standard:<sup>4</sup>
- NSF/ANSI 46–2005 Evaluation of Components and Devices used in Wastewater Treatment Systems

## 3. Terminology

3.1 For definitions of terms relating to concrete, see Terminology C 125.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *access opening, n*—hole in the top slab used to gain access to the inside of the tank for the purpose of cleaning and removing sludge without a person actually having to enter the tank.

3.2.2 *air scum volume, n*—number of cubic inches (centimetres) in the space between the liquid surface and the underside of the top slab.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C27 on Precast Concrete Products and is the direct responsibility of Subcommittee C27.30 on Water and Wastewater Containers.

Current edition approved Jan. 1, 2009. Published January 2009. Originally approved in 1993. Last previous edition approved in 2008 as C 1227 – 08.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, <http://www.aci-int.org>.

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

3.2.3 *baffle*, *n*—device placed in a tank to dissipate energy, direct flow, retain solids, and/or draw liquid off at a specific depth.

3.2.4 *baffle, inlet*, *n*—tee or wall segment at or near the inlet pipe of a tank designed to direct flow below the liquid surface.

3.2.5 *baffle, outlet*, *n*—tee or wall segment at or near the outlet pipe of a tank designed to collect flow from the liquid effluent layer.

3.2.6 *cement*, *n*—powdered substance of lime and clay mixed with water to make concrete.

3.2.7 *connector*, *n*—device that provides a flexible seal between a pipe and the precast concrete tank.

3.2.8 *corrosion-resistant*, *adj*—materials that are resistant to deterioration when in contact with the corrosive materials found in a septic tank.

3.2.9 *dead load*, *n*—mass of a structure and all permanent loads imposed on the structure (that is, soil).

3.2.10 *detention time*, *n*—average length of time a unit volume of liquid or a suspended particle remains in a tank; mathematically, it is the volume of liquid in the tank divided by the flow rate through the tank.

3.2.11 *effective volume*, *n*—maximum amount of liquid and solids that can be contained in a tank under normal operating conditions.

3.2.12 *effluent filter device*, *n*—device, made from corrosion-resistant materials, that separates solid material from tank liquid before the liquid exits the tank.

3.2.13 *grinder*, *n*—device for grinding and flushing cooking wastes; also known as a garbage disposal.

3.2.14 *inspection opening*, *n*—hole in the top slab used for the purpose of observing conditions inside the tank.

3.2.15 *joint*, *n*—physical separation where two pieces of precast concrete are in contact.

3.2.16 *liquid effluent layer*, *n*—area in a tank made up of liquids and semibuoyant waste particles after the sludge and scum waste have separated and settled.

3.2.17 *live load*, *n*—loads exerted on or above a structure when the source of the load is dynamic and transient.

3.2.18 *non-sealed joint*, *n*—joint in which sealant is not used but in which a machined fit will minimize the movement of liquid from one side of a precast concrete wall to the opposite side.

3.2.19 *owner*, *n*—is by definition, end user, customer, or purchaser.

3.2.20 *rated volume*, *n*—depth from the bottom of a septic tank to the invert of the outlet pipe.

3.2.21 *scum layer*, *n*—buoyant waste floating near the surface of liquid, consisting of lighter-than-water materials, such as greases and soaps.

3.2.22 *sealed joint*, *n*—joint that is sealed to prevent liquid passing from one side of a precast concrete wall to the opposite side.

3.2.23 *septic tank system*, *n*—anaerobic digestion chamber in which domestic sewage is received and retained, and from which the liquid effluent, which is comparatively free from settleable and floating solids, is then discharged.

3.2.24 *sludge layer*, *n*—heavier waste solids that separate and settle at the bottom of a tank.

3.2.25 *tee*, *n*—“T”-shaped pipe fitting made of corrosion-resistant materials used to connect horizontal piping with vertical piping and used to provide access for cleaning piping.

#### 4. Ordering Information

4.1 The purchaser shall include the following information in bidding documents and on the purchase order, as applicable to the units being ordered:

4.1.1 Reference to this specification and date of issue.

4.1.2 Quantity, that is, number of units ordered.

4.1.3 Capacity of tank in gallons or litres.

4.1.4 Special cement requirements including moderate sulfate-resisting cement, Specification **C 150** Type II, or highly sulfate-resisting cement, Specification **C 150**, Type V. If the purchaser does not stipulate, the manufacturer shall use any cement meeting the requirements of Specification **C 150** or **C 595**.

4.1.5 Acceptance will be based on a review of the calculations or on proof tests.

4.1.6 Design requirements such as depth of earth cover, live load applied at the surface, and ground water level.

4.1.7 Testing for water leakage shall not be required at the job site unless specifically required by the purchaser.

4.1.8 Manufacturer is permitted to require testing on site prior to backfill.

#### 5. Materials and Manufacture

5.1 *Cement*—Portland cement shall conform to the requirements of Specification **C 150** or shall be portland blast-furnace slag cement or portland-pozzolan cement conforming to the requirements of Specification **C 595**.

5.2 *Aggregates*—Aggregates shall conform to Specification **C 33** and lightweight aggregates shall conform to Specification **C 330**, except that the requirements for grading shall not apply.

5.3 *Water*—Water used in mixing concrete shall be clean and free of injurious amounts of oils, acids, alkalies, salts, organic materials, or other substances that will be incompatible with concrete or steel.

5.4 *Admixtures*—Admixtures, when used, shall conform to Specification **C 494/C 494M** or Specification **C 618** and shall not be injurious to other products used in the concrete.

5.4.1 *Air-Entraining Admixtures*—Air-entraining admixtures conforming to Specification **C 260** shall be used when there is a risk that the concrete will be exposed to freezing and thawing. Then the concrete mixture shall contain  $5.5 \pm 1.5$  % air by volume as determined by Test Method **C 231**.

5.5 *Steel Reinforcement*—Steel reinforcement shall conform to Specification **A 82/A 82M** or **A 496/A 496M** for wire, Specification **A 185/A 185M** or **A 497/A 497M** for wire fabric, or Specifications **A 615/A 615M**, **A 706/A 706M**, or **A 996/A 996M** for steel reinforcement bars.

5.5.1 *Locating Reinforcement*—Reinforcement shall be placed in the forms as required by the design.

5.5.2 *Holding Reinforcement in Position During Pouring Placement*—Reinforcement shall be securely tied or welded in place to maintain position during concrete-placing operations. Welding procedures shall conform to the appropriate material specification. Chairs, bolsters, braces, and spacers in contact with forms shall have a corrosion-resistant surface.

5.6 *Concrete Mixtures*—The aggregates, cement, and water shall be proportioned and mixed to produce a homogeneous concrete meeting the requirements of this specification, and in accordance with Specification C 94/C 94M or Specification C 685/C 685M.

5.7 *Forms*—The forms used in manufacture shall be sufficiently rigid and accurate to maintain the dimensions of the structure within the stated tolerances. All casting surfaces shall be of smooth nonporous material. Form releasing agents used shall not be injurious to the concrete.

5.8 *Concrete Placement*—Concrete shall be placed in the forms at a rate to allow the concrete to consolidate in all parts of the form, and around all reinforcement steel and embedded fixtures without segregation of materials.

5.9 *Curing*—The precast concrete sections shall be cured by any method or combination of methods that will develop the specified compressive strength at 28 days or less.

5.10 *Concrete Quality*—The quality of the concrete shall be in accordance with the chapter on concrete quality in ACI 318, except for frequency of tests, which shall be specified by the purchaser. Concrete compressive strength tests shall be conducted in accordance with Test Method C 39/C 39M.

5.11 *Fibers*—Polypropylene or polyolefin fibers are only permitted as a secondary reinforcing material, at the manufacturer's option, in precast concrete septic tanks. For the purposes of this specification, secondary reinforcing material is only used to resist temperature and shrinkage effects. Only Type III conforming to the requirements of Specification C 1116/C 1116M shall be accepted.

5.12 *Sealants*—Flexible sealants used in the manufacture and installation of tanks shall conform to Specification C 990. Rigid (mortar) sealing of tank sections is not permitted.

## 6. Structural Design Requirements

6.1 Structural design of septic tanks shall be by calculation or by performance.

6.1.1 Design by calculation shall be completed using the Strength Design Method (ultimate strength theory) or the Alternate Design Method (working stress theory) outlined in ACI 318. The Strength Design Method is outlined in Chapter 9 and the Alternate Design Method is in Appendix A.

6.1.2 Design by performance requires the manufacturer to demonstrate that failure will not occur by physically applying loads to the product. The load applied shall be 1.5 times the anticipated actual loads.

6.1.3 Tanks shall be designed so that they will not collapse or rupture when subjected to anticipated earth and hydrostatic pressures when the tanks are either full or empty.

6.1.4 After conditions are established, loads from Practice C 890 shall be used for design. Unless heavier live loads are expected, the minimum live load at the surface for design shall be 300 lbf/ft<sup>2</sup> (14 kPa).

6.1.5 The live loads imposed at lifting points shall be considered in the design of the structure.

6.1.6 Inserts embedded in the concrete shall be designed for an ultimate load that is four times the working load (Factor of Safety = 4).

6.2 *Concrete Strength*—The minimum compressive strength (*f*'*c*) for designs shall be 4000 psi (28 MPa) at 28 days of age.

6.3 *Reinforcing Steel Placement*—The concrete cover for reinforcing bars, mats, or fabric shall not be less than 1 in. (25 mm).

6.4 *Openings*—The structural design shall take into consideration the number, placement, and size of all openings.

6.5 Lift equipment shall be designed for an ultimate load that is five times the working load (Factor of Safety = 5).

## 7. Physical Design Requirements

7.1 *Capacity*—Sizes are generally specified by local regulations and they shall supersede the following guidelines. When local regulations are not available, the following minimum sizes will be required:

1-bedroom residence	750 gal (2800 L)
2 and 3-bedroom residence	1000 gal (3800 L)
4-bedroom residence	1200 gal (4500 L)
5-bedroom residence	1400 gal (5300 L)
Motels	100 gpd/unit (380 Lpd/unit)
Restaurant	70 gpd/seat (265 Lpd/seat)
Office building	20 gpd/seat (75 Lpd/seat)

Additional capacity is required when grinders are available

### 7.2 Shape:

7.2.1 There shall be a total of no less than 25 ft<sup>2</sup> (2.3 m<sup>2</sup>) of surface liquid area and a total inside length of at least 6 ft (2 m) between inlet and outlet of the tank.

7.2.2 The air scum volume above the liquid shall be at least 12½ % of the volume of liquid but not less than 9 in. (230 mm) high for entire surface above liquid.

7.2.3 Minimum water depth shall be 36 in. (900 mm) unless otherwise approved by local code or jurisdiction.

7.2.4 Maximum liquid depth shall be 72 in. (1800 mm) unless otherwise approved or required by local codes or jurisdiction.

### 7.3 Compartments:

7.3.1 The septic tank system shall include two compartments unless otherwise approved by local codes or jurisdiction. The two-compartment dividing wall is to be monolithically cast or placed secondarily utilizing a non-sealed joint with the tank body.

7.3.2 One double unit or two single compartment units in series are acceptable.

7.3.3 The first compartment shall have a liquid volume of approximately two thirds of the liquid volume of the entire contents of the system.

7.3.4 The transfer port between compartments shall be sized to maintain a low velocity as liquid moves between compartments. A minimum of 50 in.<sup>2</sup> (320 cm<sup>2</sup>) shall be used where local codes do not specify otherwise.

7.3.5 The transfer port shall be in the middle 25 % of the distance from the bottom of the tank to the water line.

7.3.6 No baffle, tee, outlet filter unit, or compartment wall shall extend to the interior roof without providing for venting. The cross-sectional area of a vent shall be at least equivalent to a 4-in. (100-mm) diameter pipe.

### 7.4 Influent and Effluent Pipes:

7.4.1 The influent pipe shall be no less than 4 in. (100 mm) in diameter.

7.4.2 The difference between the invert of the influent pipe and the invert of the effluent pipe shall be a minimum of 2 in. (50 mm) and a maximum of 4 in. (100 mm).

7.4.3 Inlet and outlet pipes shall be connected to the tank with a sealed flexible joint connector to accommodate tank movement.

**7.5 Baffles and Outlet Devices:**

7.5.1 Baffles or tees shall be placed at the influent pipe. Outlet filter devices shall be placed at the effluent pipe.

7.5.2 Baffles or tees are permitted to be precast monolithically with the tank. If baffles, tees, or outlet filters are added, they shall be made of noncorrosive materials and be permanently connected with noncorrosive fasteners to either the inside of the tank or the outlet pipe.

7.5.3 The inlet baffle or tee shall extend at least 8 in. (200 mm) below the liquid level and at least 5 in. (125 mm) above the liquid level.

7.5.4 The outlet filter shall extend below the liquid line at least 10 in. (250 mm) but not more than 40 % of the depth of the liquid. It shall extend a minimum of 5 in. (125 mm) above the liquid level line. The filter device shall be constructed to prevent the discharge of floating solids in the event the liquid level in the tank overflows the top of the filter with the filter element in place. All filter devices must meet the performance criteria of NSF/ANSI Standard 46–2005 or most current revision.

7.5.5 Outlet filter device shall be maintained in accordance with manufacturer’s recommendations or requirements of regulating agencies, or both.

7.5.6 Outlet filter devices shall be sized upon the estimated daily water use and the rated capacity of the filter per the manufacturer’s specifications.

7.5.7 Specifications for baffles, tees, and outlet filter devices are for normal, low-flow conditions. High-flow conditions, created when liquid is pumped from another tank, will require consideration for other dimensions. Design by a qualified engineer is required for these cases.

7.5.8 Outlet solids deflectors may be used in conjunction with outlet filter devices to deflect suspended solids away from the outlet filter device and shall be installed per the manufacturer’s instructions.

**7.6 Openings in Top Slab:**

7.6.1 An access opening shall be located over the influent pipe and the effluent pipe. Where an opening has any dimension greater than 12 in. (300 mm), the lid shall weigh a minimum of 59 lb (27 kg) or be provided with a lock system to prevent unauthorized entrance.

7.6.2 An access opening or openings shall be provided to permit pumping of all compartments.

7.6.3 An inspection hole, at least 4 in. (100 mm) in diameter, shall be located over an interior divider in a two-compartment tank.

7.6.4 Handles shall be provided when the top of a cover is flush with the top of the top slab. Handles shall be made of corrosion-resistant material and be capable of supporting the weight of the cover.

7.6.5 Handles are not required when the cover sits on top of the slab. The cover shall be prevented from moving laterally if sitting on top of the slab.

7.6.6 Where covers are flush with or above ground, they shall be provided with a lock system to prevent unauthorized entrance.

7.6.7 If cover is below grade, it shall have a minimum of 6 in. (150 mm) and a maximum of 12 in. (300 mm) of earth above.

7.6.8 If top slab is more than 12 in. (300 mm) below grade, risers will be required to make the top of the cover meet the requirements of 7.6.7.

**8. Quality Control and Sampling**

8.1 The manufacturer shall certify that the product meets three criteria: (1) water tightness, (2) physical dimensions, and (3) strength of structure.

NOTE 1—Installation to be in accordance with manufacturer’s instructions.

8.2 When the purchaser specifies in the bidding documents and the purchase order, the manufacturer shall select at random 1 of every 20 septic tanks to determine compliance with the provisions of this specification.

**9. Performance Test Methods**

9.1 Proof testing is used to demonstrate the strength of the tank to resist anticipated external and internal loads.

9.1.1 Proof testing, when required by the purchaser, shall be performed in such a way as to simulate the actual anticipated loads.

9.2 Testing for leakage is performed using either vacuum testing or water-pressure testing.

9.2.1 *Vacuum Testing*—Seal the empty tank and apply a vacuum to 4 in. (100 mm) of mercury. The tank is approved if 90 % of vacuum is held for 2 min.

9.2.2 *Water-Pressure Testing*—Seal the tank, fill with water, and let stand for 24 h. Refill the tank. The tank is approved if water level is held for 1 h.

**10. Dimensions and Permissible Variations**

10.1 *Dimensional Tolerances*—The length, width, height, or diameter measurements of the structure when measured on the inside surface shall not deviate from the design dimensions more than the following:

Dimension	Tolerance
0 to 5 ft (0 to 1.5 m)	±¼ in. (±6 mm)
5 to 10 ft (1.5 to 3.0 m)	±⅜ in. (±10 mm)
10 to 20 ft (3.0 to 6.1 m)	±½ in. (±13 mm)
20 ft (6.1 m) and over	as agreed upon between the manufacturer and the purchaser

10.2 *Squareness Tolerance*—The inside of the rectangular precast concrete component shall be square as determined by diagonal measurements. The difference between such measurements shall not exceed:

Measured Length	Allowance Difference
0 to 10 ft (0 to 3.0 m)	½ in. (13 mm)
10 to 20 ft (3.0 to 6.1 m)	¾ in. (19 mm)
20 ft (6.1 m) and over	as agreed upon between the manufacturer and the purchaser

10.3 *Joint Surfaces*—The following joint tolerances for water-retaining structures shall apply:

10.3.1 *Flexible Joint*—The sealed joint gap between two mating joint surfaces shall not exceed ⅜ in. (10 mm) before the joint sealant is applied.

10.4 *Reinforcement Location*—With reference to thickness of wall or slab, reinforcement shall be within  $\pm 1/4$  in. (6 mm) of the design location, but in no case shall the cover be less than 1 in. (25 mm). The variation in reinforcement spacing shall not be more than one tenth of the designed bar spacing nor exceed 1½ in. (38 mm). The total number of bars shall not be less than that computed using the design spacing.

## 11. Repairs

11.1 Repairs of precast concrete structures, when required, shall be performed by the manufacturer in a manner ensuring that the repaired structure will conform to the requirements of this specification.

## 12. Rejection

12.1 Precast concrete structures or sections of structures shall be subject to rejection because of failure to conform to any of the requirements contained in this specification.

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).*

## 13. Product Marking

13.1 Each septic tank shall be clearly marked within 2 ft (0.6 m) of the inlet to the tank by indentation or other approved means with (1) date manufactured, (2) name or trademark of the manufacturer, and (3) tank capacity. The tank or tank cover shall also be marked within 2 ft (0.6 m) of the inlet either on the cover or on the tank with an indication of external loads for which the septic tank is designed to resist, including the number of feet of earth cover above top slab and surface load from Practice C 890, that is, A-03, A-8, A-12, or A-16, unless required otherwise by local codes.

13.2 Each septic tank shall be clearly marked by indentation, or other approved means with (1) date of manufacture, (2) name or trademark of the manufacturer, and (3) indication of external loads for which the septic tank is designed to resist, including the number of feet of earth cover above top slab and surface load from Practice C 890, that is, A-03, A-8, A-12, or A-16, unless required otherwise by local codes.

13.2.1 When all the requirements of this specification are met, the product shall be so stamped.

13.3 Where an access opening or an inspection opening has a dimension greater than 8 in. (200 mm), a label of noncorrosive material shall be placed in a prominent place to warn everyone that “Entrance into the tank could be fatal.”

## 14. Keywords

14.1 anaerobic digestion; on-site wastewater treatment; sanitary waste; septic tank; sewer; sewer treatment