

"EXHIBIT A"

# AASHTO STANDARD SPECIFICATIONS

Gray Iron Castings M 105-06

Drainage, Sewer, Utility and  
Related Castings M 306-05



**Standard Specification for  
Gray Iron Castings**  
**AASHTO Designation: M 105-06**

SCOPE / REFERENCE DOCUMENTS / MATERIALS / MANUFACTURE  
PROOF-LOAD TESTING / MATERIAL TESTING / INSPECTION  
CERTIFICATION / MARKING / RECORDS

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# Standard Specification for Gray Iron Castings

AASHTO Designation: M 105-06

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## 1. SCOPE

- 1.1. This specification covers gray iron castings intended for general engineering use where tensile strength is a major consideration. Castings are classified on the basis of the tensile strength of the iron in cast test bars.
  - 1.1.1. This specification subordinates chemical composition to tensile strength.
- 1.2. Castings produced to this specification are graded on the basis of minimum tensile strength obtained in special test coupons designed to standardize cooling rate. The tensile strength developed in certain casting sections may vary from test coupon values. (See X1.2.)
- 1.3. The values stated in SI units are to be regarded as the standard.
- 1.4. AASHTO M 306 may be specified for drainage structure castings such as frames, grates, rings, and covers for inlets, manholes, and other structures if loading requirements exceed normal highway loading or if more restrictive dimensional tolerances are required.

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## 2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
  - M306, Drainage, Sewer, Utility, and Related Castings
  - T 68, Tension Testing of Metallic Materials
- 2.2. *ASTM Standards:*
  - A 644, Terminology Relating to Iron Castings
  - A 48, Gray Iron Castings
- 2.3. *Military Standard:*
  - MIL-STD-129, Marking for Shipment and Storage<sup>1</sup>
- 2.4. *Federal Standard:*
  - Fed. Std. No. 123, Marking for Shipment (Civil Agencies)<sup>1</sup>

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## 3. TERMINOLOGY

- 3.1. *Definitions:*
  - 3.1.1. Definitions for many terms common to gray iron castings are found in ASTM A 644.

- 3.1.2. *manufacturer*-a producing foundry/facility where iron is melted and poured into molds.
- 3.1.3. *supplier*-an agent, representative, or organization that provides castings that it did not manufacture.
- 3.1.4. *purchaser*-the end user of the casting.

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## 4. CLASSIFICATION

- 4.1. Castings ordered and produced in accordance with this specification are classified into a number of grades based on the properties of cast test bars (Table 1). Each class is designated by a number followed by a letter. The number indicates the minimum tensile strength of the cast test bar, and the letter indicates the size of the test bar. Examples of proper designations are as follows:
- Gray Iron Castings, M 105, Class 30B
  - Gray Iron Castings, M 105, Class 40C

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## 5. ORDERING INFORMATION

- 5.1. Orders for material to this specification shall include the following information:
- 5.1.1. AASHTO designation number and year of issue;
  - 5.1.2. Class of iron required (Section 4.1 and Table 1);
  - 5.1.3. The size of the cast test bar (letter classification-A, B, C, or S) that best represents the thickness of the controlling section of the casting (Table 3);
  - 5.1.4. The tension test specimen (B or C) to be machined from test bar C (Section 11.3, Table 2, and Figure 2);
  - 5.1.5. The tension test specimen to be machined from test bar S (Section 11.4, Table 2, and Figure 2);
  - 5.1.6. Lot size (Section 14);
  - 5.1.7. Special requirements (Section 7);
  - 5.1.8. Saving tested specimens or unbroken test bars (Section 16.4); and
  - 5.1.9. Special preparation for delivery (Section 18).

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## 6. TENSILE REQUIREMENTS

- 6.1. Test bars representing castings conforming to this specification shall meet the requirements for tensile strength as described in Table 1.

**Table 1- Requirements for Tensile Strength of Gray Cast Irons in Cast Tests Bars**

Class	Tensile Strength Min, MPa (ksi)	Nominal Test Bar, Dia, mm (in.)	Class	Tensile Strength Min, MPa (ksi)	Nominal Test Bar, Dia, mm (in.)
No. 20A	138 (20)	22.4 (0.88)	No. 45A	310 (45)	22.4 (0.88)
No. 20B		30.5 (1.2)	No. 45B		30.5 (1.2)
No. 20C		50.8 (2.0)	No. 45C		50.8 (2.0)
No. 20S		Bar S <sup>a</sup>	No. 45S		Bar S <sup>a</sup>
No. 25A	172 (25)	22.4 (0.88)	No. 50A	345 (50)	22.4 (0.88)
No. 25B		30.5 (1.2)	No. 50B		30.5 (1.2)
No. 25C		50.8 (2.0)	No. 50C		50.8 (2.0)
No. 25S		Bar S <sup>a</sup>	No. 50S		Bar S <sup>a</sup>
No. 30A	207 (30)	22.4 (0.88)	No. 55A	379 (55)	22.4 (0.88)
No. 30B		30.5 (1.2)	No. 55B		30.5 (1.2)
No. 30C		50.8 (2.0)	No. 55C		50.8 (2.0)
No. 30S		Bar S <sup>a</sup>	No. 55S		Bar S <sup>a</sup>
No. 35A	241 (35)	22.4 (0.88)	No. 60A	414 (60)	22.4 (0.88)
No. 35B		30.5 (1.2)	No. 60B		30.5 (1.2)
No. 35C		50.8 (2.0)	No. 60C		50.8 (2.0)
No. 35S		Bar S <sup>a</sup>	No. 60S		Bar S <sup>a</sup>
No. 40A	276 (40)	22.4 (0.88)			
No. 40B		30.5 (1.2)			
No. 40C		50.8 (2.0)			
No. 40S		Bar S <sup>a</sup>			

<sup>a</sup>All dimensions of test bar S shall be as agreed upon between the manufacturer and the purchaser.

## 7. SPECIAL REQUIREMENTS

- 7.1. When agreed upon in writing between the manufacturer and the purchaser, it may be necessary for the castings to meet special requirements as to hardness, chemical composition, microstructure, pressure tightness, radiographic soundness, dimensions, surface finish, etc.

## 8. DIMENSIONAL REQUIREMENTS

- 8.1. The castings shall conform to the dimensions or drawings furnished by the purchaser, or, if there are no drawings, to the dimensions predicted by the pattern equipment supplied by the purchaser.

## 9. WORKMANSHIP AND FINISH

- 9.1. The surface of the casting shall be free of adhering sand, scale, cracks, and hot tears, as determined by visual examination.
- 9.2. No repairing by plugging or welding of any kind shall be permitted unless written permission is granted by the purchaser.

## 10. CAST TEST BARS

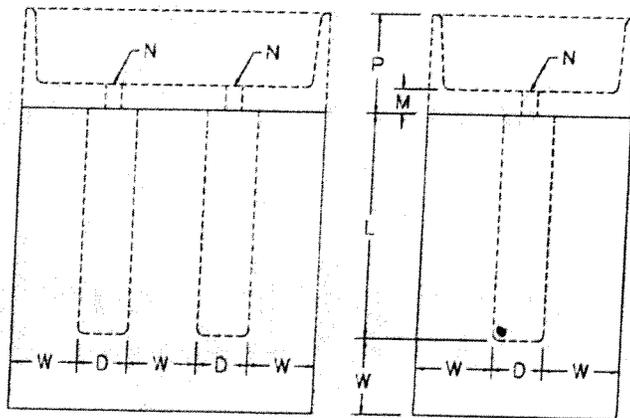
- 10.1. Test bars shall be poured from the same lot as the castings they represent, and shall have dimensions as shown in Table 2. Allowance may be made for reasonable pattern draft within the tolerances shown in Table 2. Test bars A, B, and C are all standard test bars in the form of simple cylinders. Test bar S is special and is intended for use where the standard bars are not satisfactory.

**Table 2 – Diameters and Lengths of Cast Test Bars**

Test Bar	As-Cast Diameter, mm (in.)			Length, mm (in.)	
	Nominal (Mid-Length)	Min (Bottom)	Max (Top)	Min (Specified)	Max (Recommended)
A	22.4 (0.88)	21.6 (0.85)	24.4 (0.96)	125 (5.0)	150 (6.0)
B	30.5 (1.20)	29.0 (1.14)	33.5 (1.32)	150 (6.0)	230 (9.0)
C	50.8 (2.00)	48.3 (1.90)	53.3 (2.10)	175 (7.0)	255 (10.0)
S*					

\*All dimensions of test bar S shall be as agreed upon by the manufacturer and the purchaser.

- 10.2. The separately cast test bars shall be cast in dried, baked, or chemically bonded molds made mainly of an aggregate of siliceous sand with appropriate binders. The average grain size of the sand shall approximate that of the sand in which castings are poured. Molds for the test bars shall be approximately at room temperature when poured. More than one test bar may be cast in a single mold, but each bar in the mold shall be surrounded by a thickness of sand that is not less than the diameter of the bar. A suitable design for a separately cast test bar mold is shown in Figure 1.



### Required Features

1. Material-Aggregate of dry siliceous sand.
2. Position-Bars vertical.
3. L--See Table 3.
4. D--See Table 3.
5. W--Not less than diameter, D.

### Optional Features

1. Number of test bars in a single mold-Two suggested.
2. Design of pouring cup.
3. P--50 mm (2 in.), suggested.
4. N--8 mm (5/16 in.) in diameter, suggested.
5. M--1.5 N, suggested.

**Figure 1** - Suitable Design and Dimensions for Mold for Separately Cast Cylindrical Tension Test Bars for Gray Iron

- 10.3. Test bars that are intended to represent castings that are cooled in the mold to less than 480°C (900°F), before shakeout, shall be cooled in their molds to a temperature less than 480°C (900°F). Then they may be cooled in still air to room temperature.
- 10.4. Test bars that are intended to represent castings that are hotter than 480°C (900°F) when shaken out of their molds, shall be cooled as described in Section 10.3 or (by agreement between the manufacturer and the purchaser) may be shaken out of their molds at approximately the same temperature as the castings they represent.
- 10.5. When castings are stress-relieved, annealed, or otherwise heat-treated, test bars shall receive the same thermal treatment and shall be treated adjacent to the castings they represent.

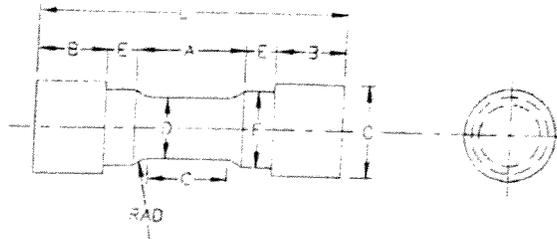
**Note 1** – The intent of these provisions is as follows: to prohibit the casting of test bars in molds of metal, graphite, zircon, light-weight aggregates, or other materials which would affect significantly the tensile strength of the iron; to prohibit control of tensile strength of the test bars by manipulation of the grain size of the sand; and to prohibit the casting of test bars in molds preheated substantially above room temperature.

**Table 3** – Cast Test Bars for Use When a Specific Correlation Has Not Been Established Between the Test Bar and the Casting

Thickness of the Wall of the Controlling Section of the Casting, mm (in.)	Test Bar
Under 6 (0.25)	S
6 to 12 (0.25 to 0.50)	A
13 to 25 (0.51 to 1.00)	B
26 to 50 (1.01 to 2)	C
Over 50 (2)	S

## 11. TENSION TEST SPECIMENS

- 11.1. For Test Bar A, the tension test specimen A, as shown in Figure 2, shall be machined concentric with the axis of the test bar.



Dimensions, mm (in.)	Tension Test, Specimen A	Tension Test, Specimen B	Tension Test, Specimen C
<i>G</i> -Length of parallel, min	13 (0.50)	19 (0.75)	32 (1.25)
<i>D</i> -Diameter	12.7 ± 0.25 (0.500±0.010)	19.1 ± 0.4 (0.750±0.015)	31.7 ± 0.050 (1.25±0.025)
<i>R</i> -Radius of fillet, min	25 (1)	25 (1)	50(2)
<i>A</i> -Length of reduced section, min	32 (1¼)	38 (1½)	57 (2¼)
<i>L</i> -Overall length, min	95 (3¾)	100 (4)	160 (6 3/8)
<i>C</i> -Dia of end section, approx	22.2 (7/8)	31.8 (1¼)	47 (1 7/8)
<i>E</i> -Length of shoulder, min	6 (1/4)	6 (1/4)	8 (5/16)
<i>F</i> -Dia of shoulder	16 ±0.5 (5/8±1/64)	25±0.5 (5/16±1/64)	36±0.5 (1 7/16±1/64)
<i>B</i> -Length of end section	*	*	*

\*Optional to fit holders on testing machine. If threaded, root diameter shall not be less than dimension, *F*.

### Figure 2 – Tension Test Specimens

- 11.2. For Test Bar B, the tension test specimen B, as shown in Figure 2 shall be machined concentric with the axis of the test bar.
- 11.3. For Test Bar C, tension test specimens B or C, as shown in Figure 2, shall be machined concentric with the axis of the test bar. Unless the size of the tension test specimen to be machined from test bar C is specified in writing by the purchaser, the decision whether to use tension test specimen B or C shall be made by the manufacturer of the castings.
- 11.4. For Test Bar S, the nature and dimensions of the tension test specimen shall be determined by agreement between the manufacturer and the purchaser.

## 12. TENSION TEST

- 12.1. Tension test specimens shall fit the holders of the testing machine in such a way that the load shall be axial.
- 12.2. The elapsed time from the beginning of loading in the tension test to the instant of fracture shall be not less than 15 seconds for test specimen A and not less than 20 seconds for specimens B and C.

## 13. NUMBER OF TESTS AND RETESTS

- 13.1. The tension test shall be conducted in accordance with T 68.

- 13.2. One tension test shall be performed on each lot and shall conform to the tensile requirements specified.
- 13.3. If the results of a valid test fail to conform to the requirements of this specification, two retests shall be made. If either retest fails to meet the specification requirements, the castings represented by these test specimens shall be rejected. A valid test is one wherein the specimen has been properly prepared and appears to be sound and on which the approved test procedure has been followed.
- 13.4. If sufficient cast test pieces are not available, the manufacturer shall have the option of removing a test specimen from a location of representative casting, as agreed upon between the manufacturer and purchaser.
- 13.5. If the first test results indicate that a heat treatment is needed to meet the test requirements, the entire lot of castings and the representative test specimens shall be heat-treated together. Testing shall proceed in accordance with Sections 13.1 through 13.4.
- 13.6. If after testing, a test specimen shows evidence of a defect, the results of the test may be invalidated and another test made on a specimen from the same lot.

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## 14. SAMPLING

- 14.1. *A lot shall consist of one of the following:*
  - 14.1.1. All the metal poured from a single heating in a batch type melting furnace.
  - 14.1.2. All the metal from two or more batch type melting furnaces poured into a single ladle or a single casting.
  - 14.1.3. All the metal poured from a continuous melting furnace for a given period of time between changes in charge, processing conditions, or aim-for chemistry or four hours, whichever is the shorter period.
    - 14.1.3.1. The purchaser may agree to extend the four-hour time period to eight hours if the manufacturer can demonstrate sufficient process control to warrant such an extension.
  - 14.1.4. One ladle of iron having a mass of over 910 kg (2000 lb).
- 14.2. When an individual casting is poured from more than one ladle of iron or when the iron for that casting is melted in more than one melting unit or from a different melt or a different type of charge in the same melting unit, or both, the iron from each melting unit, melt, or type of charge shall be considered a different lot.
- 14.3. When more than one lot of iron is used to pour a single casting, the iron in each lot must conform to this specification.
- 14.4. When an individual casting is poured with iron melted in more than one melting unit or from more than one melt or type of charge in the same melting unit, and when the irons from the different sources are mixed together thoroughly in a ladle before the casting is poured, the mixed iron in that ladle may be considered a lot.

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## 15. INSPECTION

- 15.1. Unless otherwise specified in the contract or purchase order, the manufacturer shall be responsible for carrying out all the tests and inspections required by this specification, using purchaser approved reliable facilities, and he shall maintain complete records of all such tests and inspections. Such records shall be available for review by the purchaser.

Two separate and alternative basis of acceptance are permitted. If the producing foundry is located within the United States of America, and operates in accordance with an acceptable Quality System approved by the purchaser, all castings must adhere to the inspection criteria listed in Section 15.1.1. If the producing foundry is not located within the United States of America, or if the producing foundry is located within the United States of America and it is not operating in accordance with an acceptable Quality System approved by the purchaser, all castings must adhere to the inspection criteria listed in Section 15.1.2.

- 15.1.1. *Acceptance on the Basis of Separately Cast Test Bars*-Before supplying any castings to a purchaser, the supplier/manufacturer must first submit to the purchaser, documentation that a Quality System is in place to ensure material compliance and such Quality System must be acceptable to the purchaser. Thereafter, acceptability of the castings produced in accordance with this specification shall be by certification of the results of material tests conducted on separately cast test bars, and by inspection of the finished castings for freedom from defects. The supplier/manufacturer shall provide certification that the test bars furnished for the testing represent the castings furnished for the order. If there are more than three test bar failures in one calendar year, the producing facility shall immediately report the three failing test results to the purchaser and shall discontinue supplying product. In order for the producing foundry to resume supplying, documentation that a new Quality System is in place to ensure material compliance must be submitted to and accepted by the purchaser. The purchaser shall also have the option of allowing production under Section 15.1.2.
- 15.1.2. *Acceptance on the Basis of Cast-On Test Bars*-A test bar for determining the class of iron shall be cast on a member at a place where it can be easily broken off with a breakage pattern remaining on the member. Test bars shall be of sufficient size for the supplier to produce a machined test specimen complying with the dimension requirements for a Type B test bar as shown in Table 2. The test bar shall be furnished to the purchaser for each casting in a lot. For lots of 10 or less, 100 percent of the test bars shall be tested by the supplier/manufacturer. For lots of 100 or less, the test bars from a minimum of 10 castings selected at random shall be tested by the supplier/manufacturer. For lots greater than 100, a minimum of 10 percent of all test bars selected at random shall be tested by the supplier/manufacturer. All test bars shall conform to the strength requirements specified. If any of those test bars fail to conform to the strength requirements herein specified because of surface or internal defects, all additional test specimens from the entire lot must be tested by the supplier/manufacturer. Test results from all remaining specimens must conform to the strength requirements of the specification for the lot of castings to be acceptable. If the purchaser elects to select a casting for verification of test results, the member shall be furnished by the supplier at no cost to the purchaser. All test specimen preparation and testing shall be paid for by the supplier/manufacturer. Each casting that has a test bar removed from it and evaluated must be inspected for mass (weight) and dimensions. If the casting does not conform to the mass (weight) and dimensional requirements, the casting will be rejected. If a casting fails to conform to the mass (weight) or dimensional requirements, all remaining castings shall be inspected and all must conform to the requirements for the lot of castings to be acceptable.

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## 16. CERTIFICATION

- 16.1. When specified by the purchaser's order or contract, a manufacturer's certification or compliance statement that the casting or lot of castings was made, sampled, tested, and inspected in accordance with this specification, including a report of test results signed by an authorized agent of the manufacturer, shall be furnished at the time of shipment, and such certification or compliance statement shall be the basis of acceptance of the casting or lot of castings.
- 16.2. A signature is not required on the certification or test report. However, the document shall clearly identify the organization submitting the certification and the authorized agent of the manufacturer who certified the test results. Notwithstanding the absence of a signature, the organization submitting the certification is responsible for its content.
- 16.3. When castings are produced at one manufacturer and labeled with the name of another organization or manufacturer, the original certifications shall be from the foundry that produced the casting. The certification shall clearly identify the manufacturer, the physical location of the facility that produced the casting, and the organization the castings were produced for. The document shall clearly identify the authorized agent for the manufacturer and the authorized agent of the organization the castings were produced for. Any testing conducted by the supplier shall be certified by the supplier and provided to the purchaser.
- 16.4. All test results as required by this specification shall be maintained by the manufacturer for seven years and shall be made available to the purchaser upon request. All unbroken test bars shall be stored and maintained by the manufacturer or supplier for a minimum of three years and shall be made available to the purchaser upon request.
- 16.5. Records of casting certifications issued by the manufacturer shall be maintained by the manufacturer for seven years and shall be made available to the purchaser upon request.

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## 17. PRODUCT MARKING

- 17.1. When the size of the casting permits, each individual casting shall be identified by the following: name of the manufacturer, country of manufacture, AASHTO designation or ASTM designation, class by number followed by a letter indicating the minimum tensile strength and size of test bar, heat identification and cast date (MM/DD/YY), casting lettering as required by the purchaser, and the markings as required to meet federal requirements.
- 17.2. If iron for the casting is melted and poured at one foundry and labeled with the name of another organization, manufacturer, or foundry, the casting shall include the name of the producing foundry and the organization the casting is produced for. The name of the producing foundry shall be cast onto the casting with lettering of equal size and in close proximity to the name of the organization the casting is produced for. This lettering shall be cast so that the producing foundry and the organization the casting is produced for can be easily identified from the same side of the casting. The casting shall also include all markings listed in Section 17.1.

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## 18. PREPARATION FOR DELIVERY

- 18.1. Unless otherwise stated in the contract or order, the cleaning, preservation, and packing of castings for shipment shall be in accordance with the manufacturer's commercial practice. Packaging and marking shall also be adequate to identify the contents and to ensure acceptance and safe delivery by the carrier for the mode of transportation employed.

- 18.2. *U.S. Government Procurement*-When specified in the contract or purchase order, marking for shipment shall be in accordance with the requirements of Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military activities.

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## 19. KEYWORDS

- 19.1. Gray iron castings.

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## APPENDIX

(Nonmandatory Information)

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### X1. MECHANICAL PROPERTIES OF CASTINGS

- X1.1. The mechanical properties of iron castings are influenced by the cooling rate during and after solidification, by chemical composition (particularly carbon equivalent), by the design of the casting, by the design and nature of the mold, by the location and effectiveness of gates and risers, and by certain other factors.
- X1.2. The cooling rate in the mold, and, hence, the properties developed in any particular section are influenced by the presence of cores; chills and chaplets; changes in section thickness; and the existence of bosses, projections, and intersections, such as junctions of ribs and bosses. Because of the complexity of the interactions of these factors, no precise quantitative relationship can be stated between the properties of the iron in various locations of the same casting or between the properties of a casting and those of a test specimen cast from the same iron. When such a relationship is important and must be known for a specification application, it may be determined by appropriate experimentation.
- X1.3. Gray iron castings in Classes 20, 25, 30, and 35 are characterized by excellent machinability, high damping capacity, low modulus of elasticity, and comparative ease of manufacture.
- X1.3.1. Castings in Classes 40, 45, 50, 55, and 60 are usually more difficult to machine, have lower damping capacity, a higher modulus of elasticity, and are more difficult to manufacture.
- X1.4. When reliable information is unavailable on the relationship between properties in a casting and those in a separately cast test specimen, and where experimentation would be unfeasible, the size of the test casting should be so selected as to approximate the thickness of the main or controlling section of the casting.
- X1.5. If iron castings are welded (Section 9.2), the microstructure of the iron is usually altered, particularly in the vicinity of the weldment. Therefore, the properties of the casting may be adversely affected by welding. Where practical, appropriate post weld heat treatment may reduce this effect of welding.

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<sup>1</sup>Available from Standardization Documents Order Desk, Bldg. 4 Section D, Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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**Standard Specification for**  
**Drainage, Sewer, Utility, and Related Castings**

**AASHTO Designation: M 306-05**



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**1. SCOPE**

- 1.1. This specification is applicable to frames, grates, rings, and covers for inlets, manholes, and other structures for civil engineering use where items may be placed in traffic service and load bearing is a consideration.
- 1.2. The values stated in SI units are to be regarded as the standard.

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**2. REFERENCED DOCUMENTS**

- 2.1. *AASHTO Standard:*
- M 105, Gray Iron Castings
  - Standard Specifications for Highway Bridges, 17<sup>th</sup> Edition
- 2.2. *ASTM Standards:*
- A 48, Gray Iron Castings
  - A 536, Ductile Iron Castings
  - B 26, Aluminum Alloy Sand Castings
- 2.3. *Federal Specification:*
- CID A-A-60005, Frames, Covers, Gratings, Steps, Sump and Catch Basin Manhole

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**3. MATERIALS**

- 3.1. Gray Iron Castings shall conform to the requirements of AASHTO M 105 Class 35B or ASTM A 48 Class 35B.
- 3.2. Ductile Iron Castings shall conform to the requirements of ASTM A 536 Grade 80-55-06, unless otherwise specified by the customer.
- 3.3. Aluminum Alloy Castings shall conform to the requirements of ASTM B 26 Alloy 356.0 T6.

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**4. MANUFACTURE**

- 4.1. Castings shall be manufactured true to pattern and component parts shall fit together in a satisfactory manner. They shall be smooth and well cleaned by shotblasting. Circular manhole frames, covers and grates shall be furnished with machined horizontal bearing surfaces unless otherwise specified. All square and rectangular units shall be furnished with an as-cast bearing surface.

- 4.2. *Permissible Variations:*
- 4.2.1. As-cast dimensions may vary one-half the maximum shrinkage possessed by the metal or  $\pm 5.21$  millimeter per meter ( $\pm 1/16$  inch per foot.)
- 4.2.2. Mass (Weight)  $\pm 5$  percent Drawing/Specification Mass (Weight)
- 4.3. *Performance and other Requirements:*
- 4.3.1. The cover or grate shall not rock when rotated to any position in the frame.
- 4.3.2. The cover or grate shall sit down into the frame so that the top surface of the cover or grate will be flush with the top surface of the frame.
- The difference in the level between the cover or grate shall not exceed 3.2 mm (1/8 in.) at any point when placed in the frame. The cover or grate shall not sit higher than 1.6 mm (1/16 in.) over more than  $\frac{1}{4}$  of the circumference when placed in the frame.
- 4.3.3. *Welding, Plugging—Not Allowed.*
- 4.3.4. *No Painting—Unless specified by the customer.*
- 4.4. *Quality and Appearance:*
- 4.4.1. The finished casting shall show careful finished workmanship in all particulars. Castings which have been damaged either during manufacture or shipping may be rejected. Among others the following defects may be considered as constituting poor workmanship.
- 4.4.1.1. *Defects, Major* (Items that may affect casting load bearing ability): Casting could be rejected or require proof that defect is not injurious. Examples of such defects include: shrink, cracks, cold shuts, large cavities, major porosity episodes, or major sand inclusions.
- 4.4.1.2. *Defects, Minor* (Items that may affect top surface appearance): Casting could be reworked and resubmitted. Examples of such defects include: dirt, scab, slag, minor surface porosity, or minor sand inclusions.

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## 5. PROOF-LOAD TESTING

- 5.1. For first article inspection or when specified for quality conformance inspection, the frames and covers or gratings shall show no detrimental permanent deformation when a proof load of 178 kN (40,000 lb) is concentrated on a 229 mm x 229 mm (9 in. x 9 in.) area placed at the center of the cover or grate. The specified load shall be applied and held for a period of 1 minute by a suitable testing machine. Upon removal of the load, the cover or grating and frame shall be examined for cracks or detrimental permanent deformation. Permanent deformation shall not exceed 3.2 mm (1/8 in.). Any cracks shall be cause for rejection. Any permanent deformation that exceeds 3.2 mm (1/8 in.) shall be cause for rejection. All testing shall occur in the United States on a testing machine calibrated in accordance with and traceable to National Institute of Standards and Technology (NIST) standards. All castings that are subjected to the proof load test shall be destroyed.

- 5.2. The 178 kN (40,000 lb) proof load requirement listed in Section 5.1 represents a safety factor of 2.5 for H-20 or HS-20 loading. A 222 kN (50,000 lb) proof load should be used in Section 5.1 which represents a safety factor of 2.5 for H-25 or HS-25 loading.
- 5.3. *Precision and Bias*—No statement is made about the precision or the bias of Method 5.1 for measuring the ultimate strength of the casting. The result merely states if there is conformance to the criteria for success in the procedure outlined in Section 5.1.

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## 6. MATERIAL TESTING

- 6.1. Test bar testing shall be conducted in accordance with the applicable inspection requirements of Section 7. Test bar preparation and tensile testing shall be in accordance with the applicable material specification listed in Section 3. Failure to meet the material specifications shall be cause for rejection.

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## 7. INSPECTION

- 7.1. Three separate and alternative basis of acceptance are permitted. If the producing foundry is located within the United States, all castings must adhere to the inspection criteria listed in Sections 7.1.1 and 7.1.2. If the producing foundry is not located within the United States of America, all castings must adhere to the inspection criteria listed in Sections 7.1.1, and 7.1.3.
- 7.1.1. *Acceptance on the Basis of Proof Load Tests*—Acceptability of the castings produced in accordance with this specification shall be determined by the results of the proof load test as listed in Sections 5.1. and 5.2. The producing foundry shall provide information about the ultimate strength of the castings to the purchaser upon request.
- 7.1.2. *Acceptance on the Basis of Separately Cast Test Bar*—Acceptability of the castings produced in accordance with this specification shall be by certification of the results of such material tests on separately cast test bars as required by applicable material specification identified in Section 3, and by inspection of the finished castings for freedom from defects. The supplier shall provide certification that the test bars furnished for testing represent the castings furnished for the order. If the producing foundry is located within the United States and operates in accordance with an acceptable quality program it shall report material information from a separately cast test bar. If there are more than three test bar failures in one calendar year, the producing facility will be removed from the approved supplier list. In order for the producing foundry to be restored to the approved supplier list and resume supplying, documentation that a quality system is in place to ensure material compliance must be submitted to and accepted by the purchaser.
- 7.1.3. *Acceptance on the Basis of Cast-On Test Bars*—A test bar for determining the class of iron shall be cast on a member at a place where it can be easily broken off with a breakage pattern remaining on the member. Test bars shall be of sufficient size for the supplier to produce a machined test specimen complying with the dimension requirements for a Type B test bar as shown in Table 3 of AASHTO M 105 or ASTM A 48. The test bars shall be furnished to the purchaser for testing. A test bar shall be furnished to the purchaser for each casting in a lot. For lots of 10 or less, 100 percent of the test bars shall be tested. For lots of 100 or less, the test bars from a minimum of 10 castings shall be tested. For lots greater than 100 a minimum of 10 percent of all test bars shall be tested. All test bars shall conform to the strength requirements specified. If any of those test bars fail to conform to the strength requirements herein specified because of surface or internal defects, all additional test specimens from the entire lot must be tested. Test results from all remaining specimens must conform to the strength requirements of this specification for the lot of castings to be acceptable. If the purchaser elects to select a casting for verification of test results, the member shall be furnished by the supplier at no cost to the purchaser. All test specimen preparation and

testing shall be paid for by the supplier. Each casting that has a test bar removed from it and evaluated must be inspected for mass (weight) and dimensions. If the casting does not conform to the mass (weight) and dimensional requirements, the castings will be rejected. If a casting fails to conform to the mass (weight) or dimensional requirements, all remaining castings shall be inspected and all must conform to the requirements for the lot of castings to be acceptable. If the producing foundry is not located within the United States, all castings must have cast-on test bars and all castings must be evaluated using this inspection criteria. This is to ensure that the material that is evaluated is representative of the castings being inspected. If there are more than three test bar failures or mass (weight) and dimensional rejections in one calendar year, the casting supplier and producing facility will be disallowed from supplying. In order for the producing foundry to resume supplying, documentation that a quality system is in place to ensure material compliance must be submitted to and accepted by the purchaser.

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## 8. CERTIFICATION

- 8.1. All shipments to the purchaser shall include appropriate certification from the producing foundry. The certification shall state that the castings have been produced in facilities operating in accordance with the applicable laws and regulations of the United States and the appropriate state, province, or local unit of government. This certification shall also state that all samples representing each lot have been tested, inspected, and have been found to meet the requirements of this specification and the applicable ASTM material specifications listed in Section 3. Certifications shall also state country of origin of the castings. If specified in the order, a report of the test results shall be furnished.

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## 9. MARKING

- 9.1. Each individual casting shall be identified by the foundry showing the following:
- 9.1.1. Name of producing foundry and country of manufacture preceded by the words "Made in," such as "Made in USA".
  - 9.1.2. AASHTO designation or ASTM designation number.
  - 9.1.3. Class by a number followed by a letter indicating the minimum tensile strength and size of test bar.
  - 9.1.4. Heat identification and cast date (MM/DD/YY).
  - 9.1.5. Casting lettering as required by the purchaser.
  - 9.1.6. Markings as required to meet Federal requirements.

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## 10. RECORDS

- 10.1. All test results by this specification shall be maintained by the producing foundry for seven years and shall be made available to the purchaser upon request.
- 10.2. Records of casting certifications issued by a producing foundry shall be maintained by the producing foundry for seven years and shall be made available upon request.