

## SECTION 706 - CONCRETE, CLAY AND PLASTIC PIPE

## 706.01 (Unassigned)

## 706.02 Reinforced Concrete Pipe (RCP).

(A) **RCP for Drainage System.** RCP shall conform to AASHTO M 170 for specified diameters and strength class, and requirements below:

(1) Acceptance shall be based on:

(a) Plant Load Bearing Test results.

(b) Material Test results.

(c) Inspection for visual defects and imperfections of manufactured pipe.

(2) Using three-edge-bearing test method, pipe shall be loaded until 0.01-inch crack occurs. Pipe manufacturer shall furnish facilities and provide personnel to perform test according to AASHTO T 280 (ASTM C 497). Each section of pipe, in addition to required pipe markings, shall include project identification and inspection lot designation.

(3) Precast reinforced concrete pipe end sections shall conform to requirements above.

(B) **RCP for Sewer System.** RCP shall conform to ASTM C 76 and requirements below:

(1) **General.**

(a) RCP shall be furnished in nominal lengths of 8 or 12 feet. The Contractor may require different pipe lengths to meet special conditions. Pipes entering or leaving manholes shall have a minimum length of 24 inches.

(b) Circular or elliptical pipe reinforcement shall have one inch minimum concrete cover.

(c) Forms for molding pipe walls shall be circular throughout the length and rigid to prevent deformation. Forms shall be designed to ensure good quality product. Abutting edges shall be tight to prevent leakage.

49 Pipe ends shall be molded with rigid rings within  
50 required tolerance. Form's surface shall be wetted, oiled, or  
51 waxed to prevent bonding of concrete to form.  
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53 **(d)** Pipes shall be cast vertically or centrifugally.  
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55 **1.** Vertical steel or metallic forms shall be used for  
56 vertical casting. Inner and outer forms shall be held in a  
57 circular and concentric position. Concrete shall be  
58 compacted with high frequency external vibrations and  
59 continuously vibrated during placing of each batch.  
60 Concrete shall be placed to provide dense consolidated  
61 mixture and ensure even smooth surface finish.  
62

63 **2.** Centrifugally cast pipe shall be spun in  
64 horizontally rotating cylindrical metal form. Pipe shall be  
65 cast centrifugally in one operation without cement  
66 mortar lining.  
67

68 Concrete shall be placed in mold in continuous  
69 and uniform rate. Pipe forms shall be revolved at  
70 speeds that ensure thorough compaction of concrete.  
71 Thin layer of mortar shall be applied to form even,  
72 smooth, hard surface finish.  
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74 **(e)** Pipe shall be cured by steam, water, or combination of  
75 steam and water. Concrete shall be cured until it has reached  
76 its 28-day strength, in accordance with Section 601 – Structural  
77 Concrete. Adequate space and facilities shall be provided for  
78 proper curing.  
79

80 **1.** For centrifugally cast pipe, after spinning, mold  
81 containing pipe shall be enclosed and cured with  
82 saturated steam. Do not remove forms until after six  
83 hours of steam curing or water curing for 32 hours.  
84

85 Pipes shall be cured until test cylinders attain 28-  
86 day strength, in accordance with Section 601 –  
87 Structural Concrete.  
88

89 **2.** For vertically cast pipes, within three hours after  
90 placing concrete in forms, steam shall be applied to  
91 inner space of forms. Do not remove forms until after  
92 six hours of steam curing. Pipes shall be cured until  
93 test cylinders attain 28-day strength, in accordance with  
94 Section 601 – Structural Concrete. After concrete has  
95 attained strength of 2,000 pounds per square inch,  
96 pipes may be stored horizontally.

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**(f)** Minimum of six longitudinal reinforcing bars for each pipe shall be provided. Total required area of bars shall be calculated as follows:

1. Equivalent in area to 1/2-inch round bars spaced at 30 inches center to center measured along pipe circumference.
2. For 8 feet nominal length pipe, minimum of six 1/4-inch round bars or equivalent in steel area.
3. For 12 feet nominal length pipe, minimum of six 3/8-inch round bars or equivalent in steel area.

Most stringent steel area requirement shall govern. Longitudinal reinforcement shall be uniformly spaced around pipe circumference.

**(g)** For pipe bell and spigot, circumferential and longitudinal reinforcement shall be equal to reinforcement within pipe barrel.

**(2) Joints.**

**(a)** Joints shall be of reinforced concrete bell and spigot design using rubber gaskets for sealing. Concrete bell shall be enlarged. Spigots shall have nominal wall thickness. Flush bell and spigot joints for pipe sizes smaller than 60 inches in diameter are not acceptable.

Joint design shall be as pipe is laid, joints are self-centering, and gaskets are not supporting weight of pipe. After completing joint, gaskets shall be enclosed on four sides. Joints shall be kept tight under normal conditions of service including expansion, contraction, and earth settlement.

Pipe spigot surfaces and reinforced concrete bell shall be formed accurately to ensure tight fitting joints. Tolerances shall not exceed 1/16 inch between theoretical diameters and actual diameters of contact surfaces. Inner surface of reinforced concrete bell shall be ground.

Joints shall be designed, located, and formed accurately on each pipe section, such that completed joint restrains rubber gasket on four sides and ensures water-tight seal.

Joints shall be sealed with continuous rubber ring gasket

## 706.02

145 of size and cross section that completely fills recess provided  
146 for joint.

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148 **(b)** Rubber gaskets shall conform to ASTM C 361.

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150 Certified copy of laboratory test results showing gasket  
151 conforms to ASTM C 361 shall be submitted for acceptance by  
152 Engineer.

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154 Test results of physical properties of materials used in  
155 manufacture of gaskets shall be submitted for acceptance by  
156 Engineer.

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158 Rubber gaskets shall be stored in cool, well-ventilated  
159 location. Rubber gaskets shall not be exposed to direct  
160 sunlight.

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162 **(3) Precast Pipe Fittings.**

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164 **(a)** Fittings shall be made from cast concrete pipe sections.  
165 Minimum of twelve 5/8-inch longitudinal bars, or equivalent  
166 shall be provided, in pipes cast for fittings. Spliced longitudinal  
167 bars shall be lapped 4 inches minimum and welded.

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169 **(b)** Bends shall be mitered. Maximum bevel angle shall be  
170 22.5 degrees. Radius measured to the centerline of the bend  
171 shall be four times pipe diameter.

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173 **(C) Rejection of RCP.** Pipe may be rejected for failure to conform to  
174 specifications as follows:

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176 **(1)** Fractures or cracks passing through wall except for single end  
177 crack that does not exceed depth of joint.

178 **(2)** Defects that indicate imperfect proportioning, mixing or  
179 molding.

180 **(3)** Surface defects indicating honeycombed or open texture.

181 **(4)** Damaged or unsatisfactorily manufactured ends, if such would  
182 prevent making satisfactory joint.

183 **(5)** Continuous crack having surface width of 0.01 inch or more  
184 and extending for length of 12 inches or more, regardless of position  
185 in wall of pipe.

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188 **706.03 (Unassigned)**

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190 **706.04 (Unassigned)**

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192 **706.05 (Unassigned)**

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194 **706.06 (Unassigned)**

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196 **706.07 (Unassigned)**

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198 **706.08 Vitriified Clay Pipe (VCP) and Fittings for Sewer System.**

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200 **(A) General.** Extra strength VCP and fittings shall be first quality,  
 201 durable, sound, and properly fired throughout its entire thickness. VCP shall  
 202 conform to AASHTO M 65 and ASTM C 700.

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204 **(B) Manufacturing Requirements.**

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206 **(1) Identification Marks.** Pipe and fittings shall be clearly marked  
 207 with name or trademark of manufacturer, batch number, location of  
 208 plant, and extra strength designation.

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210 **(2) Shape.** Pipe ends shall be normal to longitudinal axis and  
 211 sockets true, circular, and concentric with pipe barrel.

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213 Pipe shall be socket and spigot type.

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215 Pipe ends shall be formed to achieve smooth, continuous  
 216 interior surface when pipes are laid together and joined.

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218 **(3) Lengths.** Straight pipe lengths shall be more than 2 feet.

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220 Fitting lengths shall be furnished to accommodate jointing  
 221 system provided. Wye fittings shall have spurs of specified size,  
 222 securely and completely fastened to barrel of fitting in manufacturing  
 223 process. Wye fittings shall have spurs with axis at angles of 60  
 224 degrees or 45 degrees to longitudinal axis of fitting, measured from  
 225 socket or bell end of fitting. Barrels shall be of sufficient length for  
 226 each spur.

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228 **(4) Dimensions and Tolerances.** VCP shall conform to Table 2A  
 229 ASTM C 700.

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231 **(5) Imperfections.** Pipes and fittings shall be free from  
 232 imperfections such as injurious cracks, checks, blisters, or broken  
 233 extremities. Pipe or fittings with following imperfections will be  
 234 rejected.

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236 **(a)** Fractures or cracks passing through barrel or socket, or

237 more than a single:

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239 1. Crack at spigot end of pipe not exceeding 75  
240 percent of depth of socket.

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242 2. Fracture in socket not exceeding 3 inches around  
243 circumference nor 2 inches lengthwise.

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245 3. Chips or fractures on inner portion of pipe  
246 exceeding 2 inches in length by 1 inch in width, and 1/4  
247 depth in thickness of barrel depth.

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249 **(b)** Lumps, blisters, pits, or flakes on interior surface.

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251 For pipe sizes from 3 inches to 18 inches, no blister  
252 shall exceed 3 inches, in any direction, and no blister or pimple  
253 shall project more than 1/8 inch above pipe surface.

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255 For pipe sizes over 18 inches, no blister or pimple shall  
256 exceed 2 inches/foot of internal pipe diameter. No blister or  
257 pimple shall project more than 1/8 inch/foot of internal diameter  
258 above pipe surface.

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260 Pipes with broken blisters are not acceptable.

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262 **(c)** Spigot or socket of pipe shall not vary from a true circle  
263 by more than 3 percent of its nominal diameter.

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265 **(d)** Pipes or fittings shall not deviate from a straight line by  
266 more than 1/16 inch per linear foot.

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268 **(e)** Socket or spigot end of pipe or fitting shall not have  
269 broken pieces.

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271 **(f)** Pipes or fittings shall not have tramp clays, grog, or  
272 other foreign matter that has fused permanently to exterior or  
273 interior surface.

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275 **(6) Caps and Branches.** Caps with pipe branches and stubs shall  
276 be securely connected to pipe. Caps shall be of polyethylene,  
277 polypropylene, polyurethane, polyvinyl chloride, ozone resistant  
278 synthetic rubber, or clay discs material.

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280 Pipe branches shall have spurs of specified sizes securely and  
281 completely fastened to pipe barrel. Fastening material such as epoxy  
282 resin or other accepted material shall have strength equal to pipe  
283 material. Wye pipe branches shall have axis approximately 45  
284 degrees from longitudinal axis of pipe, measured from socket end.

285 Pipe branches shall be terminated in sockets. Sufficient length of  
286 branch barrel shall be provided to properly join connecting pipe to  
287 branch socket.  
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**(7) Hydrostatic Pressure and Loading Test.**

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**(a) General.** Before using pipe, independent testing  
292 laboratory shall test pipe according to hydrostatic pressure test  
293 and loading test.

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**(b) Selection of Test Specimens.** Engineer will randomly  
296 select for testing, minimum of two specimens for each size in  
297 accordance with contract documents.

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Furnishing of test pipes and laboratory testing shall be  
300 at no increase in contract price or contract time.

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**(c) Acceptance or Rejection on Results of Tests.** If  
303 specimens meet requirements of tests, Engineer will consider  
304 pipes in lot, shipment or delivery corresponding to sizes and  
305 classes complying with test.

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For each pipe size, if one specimen fails to meet test  
308 requirements, second selection of pipe for that test shall be  
309 made. Second selection of pipe shall be five of each pipe size  
310 of first selection that failed to meet requirements.

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If 90 percent or more of pipe including those first tested  
313 meet test requirements, Engineer will consider pipes in lot,  
314 shipment, or delivery corresponding to sizes and classes, as  
315 complying with test.

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Otherwise, Engineer will reject pipes of these class and  
318 sizes.

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**(d) Hydrostatic Test.** Apply hydrostatic pressure test to  
320 pipes of each size and class conforming to ASTM C 301.  
321 Leakage on exterior of pipe will not be allowed, when subjected  
322 to internal hydrostatic pressure of 10 pounds per square inch  
323 for time specified in ASTM C 700.

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**(e) Loading Tests.** Selected specimens shall be tested by  
326 applying Three-Edge Bearing test conforming to ASTM C 301.

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Extra Strength Pipe shall withstand loads of each  
329 respective size and class according to Table 1, ASTM C 700-  
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**(C) Vitrified Clay Sewer Pipe Joints.** Mechanical compression joints shall be of types listed below.

**(1) Type "B" Joints (Polyurethane).** Type "B" joints shall contain two sealing components. One component shall bond to outer portion of spigot and other component shall bond to inner portion of bell. Sealing components shall be polyurethane elastomer material. Sealing components shall be bonded to pipes and fittings at pipe factory. Sealing components shall be cured to uniform hardness and compressibility. Sealing components shall be shaped, sized, bonded, and cured to form tight, dense, and homogeneous compression coupling when joint is assembled.

Type "B" joints shall conform to ASTM C 425.

**(2) Compression Couplings for Plain-End Pipe.** Couplings for plain-end pipes shall consist of rubber sleeve coupling with shear ring attached to ends of plain-end pipe and clamped with stainless steel compression bands. Compression couplings for plain-end pipe shall conform to ASTM C 425.

**706.09 PVC Pipe for Sewer System.**

**(A) General.** PVC pipe and fittings shall conform to ASTM D 3034 and below:

**(1)** Minimum wall thickness and Standard Dimension Ratio (SDR) of 35 shall be used.

**(2)** PVC pipes shall conform to cell classification of 12454-B, 13364-A, or 13364-B according to ASTM D1784. PVC fittings shall conform to cell classification of 12454-B, 12454-C, or 13343-C. Manufacturer shall pre-qualify PVC compounds of other cell classifications. Additives and fillers including stabilizers, antioxidants, lubricants, and colorants shall not exceed 10 parts by weight per 100 of PVC resin in compound.

**(B) Manufacturing Requirements.**

**(1) Identification Marks.** Pipe, fittings, and couplings shall be clearly marked at interval not to exceed 5 feet as follows:

**(a)** Manufacturer's name or trademark and code (plant, shift, and date designations).

**(b)** Nominal pipe diameter.

- 381 (c) PVC cell classification.  
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383 (d) Type PSM SDR-35 PVC Sewer Pipe.  
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385 (e) ASTM designation - D 3034.  
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387 SDR designation is not required for fittings and couplings.  
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- (2) **Shape.** Pipe ends shall be normal to longitudinal axis, with  
389 sockets true, circular and concentric with barrel of pipe.  
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391 Pipe ends shall be formed to achieve a smooth, continuous  
392 interior surface, when pipes are laid together and joined.  
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- (3) **Length.** Straight pipe lengths shall be more than 12-1/2 feet.  
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- (4) **Dimensions and Tolerances.** Outside diameter and minimum  
397 wall thickness of pipe shall conform to Table 1 ASTM D 3034.  
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- (5) **Imperfections.** Pipes and fittings shall be free from  
400 imperfections such as injurious cracks, checks, blisters, or broken  
401 extremities. Imperfections in pipe or fitting will be cause for rejection  
402 as follows:  
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- (a) Crack in barrel or bell of pipe extending through entire  
405 thickness.  
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- (b) Crack that extends through 1/5 or more of barrel or bell  
408 thickness and is over 3 inches long.  
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- (c) Crack that is more than 1/32 inch wide at its widest  
411 point.  
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- (d) Lumps, blisters, pits, or flakes on interior surface of pipe.  
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415
- (e) When spigot or bell of pipe varies from true circle of  
416 more than 3 percent of its nominal diameter.  
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- (f) When pipe or fitting, designated to be straight exhibits  
419 deviation from straight line of more than 1/16 inch per linear  
420 foot.  
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- (g) Broken pieces from socket or bell end of pipe or fitting.  
423  
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- (h) When dimensions exceed permissible variations  
425 according to Table 1 of ASTM D 3034.  
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429 (i) When foreign matter has fused permanently to exterior  
430 or interior surface of pipe or fitting.

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**(6) Tests.**

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**(a) General.** Before using pipe, independent testing  
laboratory shall test pipe and pipe shall meet test below.

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**(b) Selection of Test Pipe.** Engineer will select at random  
one test pipe for each 1,200 linear feet or fraction of each size  
of pipe delivered to job site. Engineer will select at least one  
test pipe per lot. Contract documents define lot as pipe having  
same identification marking.

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Sound pipes having dimensions consistent with contract  
documents shall be selected for testing. Pipe test specimens  
shall have minimum length of 8 feet.

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Furnishing of test pipes and laboratory testing shall be  
at no increase in contract cost or contract time.

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**(c) Acceptance.** Basis of acceptance for pipes, fittings,  
and couplings shall be inspection and results of tests specified.  
Contractor shall test each lot of pipe and fittings for impact,  
stiffness, and flattening according to ASTM D 3034.

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Pipes that are not installed within 120 days of latest  
factory test shall not be used without acceptance by Engineer.

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**(d) Pipe Flattening.** No evidence of splitting, cracking or  
breaking shall be found when pipe is tested according to ASTM  
D 3034.

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**(e) Impact Resistance.** No evidence of shattering or  
splitting shall be found when specimens are tested for impact  
resistance according to Table 12 ASTM D 3034 and ASTM D  
2444.

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**(f) Pipe Stiffness.** Minimum pipe stiffness at 5 percent  
deflection shall be specified in Table 13 ASTM D 3034 when  
calculated according to ASTM D 2412.

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**(g) Joint Tightness.** Two sections of pipe shall be joined  
together according to ASTM D 2855. No evidence of leakage  
shall be found when tested according to ASTM D 3034.

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**(h) Extrusion Quality.** No visible spalling or cracking  
shall occur when tested according to ASTM D 2152.

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**(i) Chemical Resistance.** Pipe manufacturer shall prequalify PVC compound for cell classifications not identified in Subsection 706.09(A) - General, by meeting chemical resistance tests that follow. Compound samples and molded test specimens shall be prepared according to ASTM D 543.

Tensile and Izod impact exposure specimens shall be immersed in solutions specified in Table 706-I – Test Solutions for 112 days. Test specimens shall be conditioned to constant weight at temperature of 110 degrees F before and after submersion. Solutions shall be kept at 77 degrees F plus/minus 5 degrees F. At 28-day intervals, selected specimens shall be removed, washed, surface dried, and tested.

<b>TABLE 706.09-I - TEST SOLUTIONS</b>	
<b>Chemical Solution Concentration (percent)</b>	
Sulfuric acid	20*
Sodium hydroxide	5
Ammonium hydroxide	5*
Nitric acid	1*
Ferric chloride	1
Soap	0.1
Detergent (Linear alkyl benzly sulfonate)	0.1
Bacteriological	BOD not less than 700 ppm
* Volumetric percentages of concentrated reagents of C.P. grade.	

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Weight change specimens shall be 2 inches in diameter and may be molded discs or discs cut from pipe wall. Contractor shall:

1. Condition specimens for seven days at 109 degrees F plus/minus 4 degrees F.
2. Cool in desiccator for three hours at 73 degrees F plus/minus 4 degrees F.
3. Weigh specimen.
4. Immerse in solutions.

At four-week intervals, selected specimens shall be removed, washed, surface dried, and weighed. These same specimens shall be reconditioned for seven days at 109 degrees F plus/minus 4 degrees F, then cooled in a desiccator for three hours at 73 degrees F plus/minus 4 degrees F, and again weighed.

Initial and post exposure specimens shall conform to the following requirements when tested at 73 degrees F plus/minus 4 degrees F:

<b>TABLE 706.09-2 – Initial and Post Exposure Specimen Requirements</b>				
<b>Property</b>	<b>ASTM Test Method</b>	<b>Cell Class Minimum Values</b>		
		<b>12454</b>	<b>13343</b>	<b>13364</b>
Tensile Strength (Yield), psi	D 638	7000	6000	6000
Impact Strength ft-lbs./in.	D 256 Method A	0.65	1.5	1.5
Weight Change, Percent	D 543	1.5	1.5	1.5

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If specimen fails to meet requirements during 112-day exposure period, material will be rejected.

524 **(C) Joints.** Bell and spigot type pipe joints shall have elastomeric gasket.  
 525 Joints with gaskets shall be made with integral wall bell and locked-in place  
 526 rubber ring that will ensure proper installation of gasket and ensure that  
 527 gasket remains in place during joining operation. Home mark shall be shown  
 528 on spigot end to ensure proper penetration during joint installation.  
 529

530 **(D) Certification.** Copy of manufacturer's test report or statement by  
 531 seller, and copy of test results that material was sampled, tested, and  
 532 inspected shall be submitted to Engineer for acceptance. Each certification  
 533 shall be signed by Authorized agent of seller or manufacturer.  
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535 **706.10 High Density Polyethylene Pipe.**  
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537 **(A) High Density Polyethylene Pipe for Drainage System.** Pipe shall  
 538 conform to AASHTO M 252 or M 294 Type C or Type S. Certificate of  
 539 Compliance shall be submitted to Engineer for acceptance prior to using  
 540 plastic pipe.  
 541

542 **(B) Couplings.** Couplings of same material composition as pipe shall be  
 543 furnished.  
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545 **706.11 (Unassigned)**  
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547 **706.12 Perforated Plastic Pipe.** Perforated corrugated polyethylene pipe shall  
 548 conform to AASHTO M 252 or AASHTO M 294.  
 549

550 Perforated PVC pipe shall conform to ASTM D 2729.  
 551

552 Perforated corrugated polyethylene pipe shall be Type CP corrugated surface  
 553 both inside and outside, or Type SP corrugated wall outside and smooth inner liner.  
 554

555 Certificate of Compliance shall be submitted to Engineer for acceptance  
 556 before using plastic pipes.  
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558 **706.13 (Unassigned)**  
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560 **706.14 Polyethylene Pipe.** Polyethylene pipe shall conform to ASTM D 2447, 40  
 561 and 80 or ASTM D 2239, SDR-PR.  
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563 Polyethylene pipe shall conform to PE 2305 or PE 2306, Class C, SDR 15.  
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565 PVC plastic fittings for polyethylene pipe shall conform to ASTM D 2609.  
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567 **706.15 (Unassigned)**  
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569 **706.16 (Unassigned)**  
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571 **706.17 Reinforced Concrete Low-Head Pressure Pipe.** Reinforced concrete

**706.18**

572 low-head pressure pipe shall conform to ASTM C 361, Class C 100.

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574 Bends shall be made from cast concrete pipe sections with centerline radius  
575 of two and one-half times pipe diameter with maximum deflection per miter joint of  
576 22-1/2 degrees.

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578 **706.18 Concrete Cylinder Pipe.** Concrete cylinder pipe shall conform to Federal  
579 Specification: SS-P 00385, Pipe; Pressure, Steel, Cement-Mortar Lining, and  
580 Reinforced Cement-Mortar Lining, and designed in accordance with contract  
581 documents.

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583 Pipes shall have nominal lengths of 16 to 32 feet. Fittings, curves, or  
584 closures, may be shorter.

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586 Bends shall be made from steel cylinders with cement mortar lining and  
587 reinforced cement mortar coating. Bends shall have centerline radius of 2-1/2 times  
588 pipe diameter with maximum deflection per miter joint of 22-1/2 degrees.

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**END OF SECTION 706**