

**SECTION 02525
ACCEPTANCE TESTING FOR GRAVITY SANITARY SEWERS**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Acceptance testing of sanitary sewers including:
 - 1. Visual inspection of sewer pipes.
 - 2. Mandrel testing for flexible sewer pipes.
 - 3. Leakage testing of sewer pipes.
 - 4. Leakage testing of manholes.
 - 5. Smoke testing of point repairs.
 - 6. Cleaning of Sanitary Sewer Systems.
 - 7. Television inspection of sewer pipes.
- B. All tests listed in this Section are not necessarily required on this Project. Required tests are named in other Sections which refer to this Section for testing criteria and procedures.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. No separate payment shall be made for acceptance testing under this Section. Include payment in the unit price for work requiring acceptance testing.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
 - 1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 REFERENCES

- A. ASTM – American Society for Testing and Materials.
 - 1. ASTM C924 - Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.
 - 2. ASTM D3034 - Standard Specification for Type PSM Polyethylene (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - 3. ASTM F794 - Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
 - 4. ASTM F1417 - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air.
- B. CFTS – City of Friendswood Technical Specifications.

1.4 GRAVITY SANITARY SEWER PERFORMANCE REQUIREMENTS

- A. Gravity flow sanitary sewers are required to have straight alignment and uniform grade between manholes.

- B. Flexible pipe, including "semi-rigid" pipe, is required to show no more than five percent (5%) deflection. Test pipe no sooner than thirty days (30 D) after backfilling of line segment but prior to final acceptance using standard mandrel to verify that installed pipe is within specified deflection tolerances.
- C. Maximum allowable leakage for Infiltration or Exfiltration:
 - 1. The total exfiltration, as determined by hydrostatic head test, shall not exceed fifty gallons (50 Gal) per inch diameter per mile of pipe per twenty-four hours (24 Hrs) at minimum test head of two feet (2 Ft) above crown of pipe at upstream manhole or two feet (2 Ft) above groundwater elevation, whichever is greater.
 - 2. When pipes are installed more than two feet (2 Ft) below groundwater level, use infiltration test in lieu of exfiltration test. Total infiltration shall not exceed fifty gallons (50 Gal) per inch diameter per mile of pipe per twenty-four hours (24 Hrs). Groundwater elevation must be at least two feet (2 Ft) above crown of pipe at upstream manhole.
 - 3. Refer to TABLE 4.1 WATER TEST ALLOWABLE LEAKAGE in this Section, for measuring leakage in sewers. Perform leakage testing to verify that leakage criteria are met.
- D. Perform air testing in accordance with requirements of this Section and Texas Commission on Environmental Quality (TCEQ) requirements. Refer to TABLE 4.2 – TIME ALLOWED FOR PRESSURE LOSS FROM 5.0 PSI TO 4.0 PSI and TABLE 4.3 MINIMUM TESTING TIMES FOR LOW PRESSURE AIR TEST in this Section.
- E. Perform vacuum testing of manholes in accordance with requirements of this Section and Texas Commission on Environmental Quality (TCEQ) requirements. Refer to TABLE 4.4 – VACUUM TESTING TIMETABLE in this Section.

1.5 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Test Plan: Before testing begins and in adequate time to obtain approval through submittal process, prepare and submit test plan for approval by the Project Manager. Include testing procedures, methods, equipment, and tentative schedule. Obtain advance written approval for deviations from the Drawings and the Specifications.
- C. Test Reports: Submit test reports for each test on each segment of sanitary sewer.

1.6 GRAVITY SANITARY SEWER QUALITY ASSURANCE

- A. Repair, correct, and retest manholes or sections of pipe which fail to meet specified requirements when tested.
- B. Provide testing reports and DVD media of television inspection as directed by the Project Manager and as specified in Section 02520 – Television Inspection of Sanitary Sewer Lines.

- C. Upon completion of DVD media reviews by the Project Manager, the Contractor shall be notified regarding final acceptance of the gravity sanitary sewer segment.

1.7 SEQUENCING AND SCHEDULING

- A. Perform testing as work progresses. Schedule testing so that no more than one thousand linear feet (1000 Lf) of installed gravity sanitary sewer remains untested at one (1) time.
- B. Coordinate testing schedules with the Project Manager. Perform testing under observation of the Project Manager.

PART II: PRODUCTS

2.1 DEFLECTION MANDREL

- A. Mandrel Sizing: Rigid mandrel shall have outside diameter (O.D.) equal to ninety-five percent (95%) of inside diameter (I.D.) of pipe. Inside diameter of pipe, for purpose of determining outside diameter of mandrel, shall be average outside diameter minus two (2) minimum wall thicknesses for O.D. controlled pipe and average inside diameter for I.D. controlled pipe, dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.
- B. Mandrel Design: Rigid mandrel shall be constructed of metal or rigid plastic material that can withstand two hundred pounds per square inch (200 psi) without being deformed. Mandrel shall have nine (9) or more "runners" or "legs" as long as total number of legs is odd number. Barrel section of mandrel shall have length of at least seventy-five percent (75%) of inside diameter of pipe. Rigid mandrel shall not have adjustable or collapsible legs which would allow reduction in mandrel diameter during testing. Provide and use proving ring for verifying each size of mandrel.
- C. Proving Ring: Furnish "proving ring" with each mandrel. Fabricate ring of one-half inch (1/2 In) thick, three inch (3 In) wide bar steel to diameter 0.02 inches larger than approved mandrel diameter.
- D. Mandrel Dimensions [five percent (5%) allowance]: Average inside diameter and minimum mandrel diameter are specified in TABLE 4.5 – PIPE VS. MANDREL DIAMETER in this Section. Mandrels for higher strength, thicker wall pipe or other pipe not listed in table may be used when approved by the Project Manager.

2.2 EXFILTRATION TEST

- A. Water Meter: Obtain transient water meter from the City for use when water for testing shall be taken from the City system. Conform to the City requirements for water meter use.
- B. Test Equipment:
 - 1. Pipe plugs.

2. Pipe risers where manhole cone is less than two feet (2 Ft) above highest point in pipe or service lead.

2.3 INFILTRATION TEST

A. Test Equipment:

1. Calibrated ninety degree (90°) V-notch weir.
2. Pipe plugs.

2.4 LOW PRESSURE AIR TEST

A. Minimum Requirement for Equipment:

1. Control panel.
2. Low-pressure air supply connected to control panel.
3. Pneumatic plugs: Acceptable size for diameter of pipe to be tested; capable of withstanding internal test pressure without leaking or requiring external bracing.
4. Air hoses from control panel to:
 - a. Air supply.
 - b. Pneumatic plugs.
 - c. Sealed line for pressuring.
 - d. Sealed line for monitoring internal pressure.

- #### B. Testing Pneumatic Plugs:
- Place pneumatic plug in each end of length of pipe on ground. Pressurize plugs to a minimum of twenty-five pounds per square inch (25 psi); then pressurize sealed pipe to five pounds per square inch (5 psi). Plugs are acceptable when they remain in place against test pressure without external aids.

2.5 GROUND WATER DETERMINATION

- #### A. Equipment:
- Pipe probe or small diameter casing for ground water elevation determination.

2.6 SMOKE TESTING

A. Equipment:

1. Pneumatic plugs.
2. Smoke generator as supplied by Superior Signal Company, or approved equal.
3. Blowers producing two thousand five hundred Standard Cubic Feet per Minute (2500 Scfm) minimum.

PART III: EXECUTION

3.1 PREPARATION

- #### A.
- Provide labor, equipment, tools, test plugs, risers, air compressor, air hose, pressure meters, pipe probe, calibrated weirs, or any other device necessary for proper testing and inspection.
- #### B.
- Determine selection of test methods and pressures for gravity sanitary

sewers based on ground water elevation. Determine ground water elevation using equipment and procedures conforming to Section 01585 - Control of Ground and Surface Water.

3.2 VISUAL INSPECTION OF GRAVITY SANITARY SEWERS

- A. Check pipe alignment visually by flashing light between structures. Verify if alignment is true and no pipes are misplaced. In case of misalignment or damaged pipe, remove and relay or replace pipe segment.

3.3 MANDREL TESTING FOR GRAVITY SANITARY SEWERS

- A. Perform deflection testing on flexible and semi-rigid pipe to confirm pipe has no more than five percent (5%) deflection. Mandrel testing shall conform to ASTM D3034. Perform testing no sooner than thirty days (30 D) after backfilling of line segment, but prior to final acceptance testing of line segment.
- B. Pull approved mandrel by hand through gravity sanitary sewer sections. Replace any section of gravity sanitary sewer not passing mandrel. Mandrel testing is not required for stub-outs.
- C. Retest repaired or replaced gravity sanitary sewer sections.

3.4 LEAKAGE TESTING FOR GRAVITY SANITARY SEWERS

- A. Test Options:
 - 1. Test gravity sanitary sewer pipes for leakage by either exfiltration or infiltration methods, as appropriate, or with low pressure air testing.
 - 2. Test new, replacement or rehabilitated gravity sanitary sewer manholes with water or low-pressure air. Manholes tested with low pressure air shall undergo physical inspection prior to testing.
 - 3. Perform leakage testing after backfilling of line segment, and prior to tie-in of service connections.
 - 4. If no installed piezometer is within 500 feet of gravity sanitary sewer segment, provide temporary piezometer for this purpose.
- B. Compensating for Ground Water Pressure:
 - 1. Where ground water exists, install pipe nipple at same time gravity sanitary sewer line is placed. Use one-half inch (1/2 In) capped pipe nipple approximately ten inches (10 In) long. Make installation through manhole wall on top of gravity sanitary sewer line where line enters manhole.
 - 2. Immediately before performing line acceptance test, remove cap, clear pipe nipple with air pressure, and connect clear plastic tube to nipple. Support tube vertically and allow water to rise in tube. After water stops rising, measure height in feet of water over invert of pipe. Divide this height by two and three-tenths feet/pounds per square inch (2.3 Ft/psi) to determine ground water pressure to be used in line testing.

- C. Exfiltration test:
1. Determine ground water elevation.
 2. Plug sewer in downstream manhole.
 3. Plug incoming pipes in upstream manhole.
 4. Install riser pipe in outgoing pipe of upstream manhole when highest point in service lead (house service) is less than two feet (2 Ft) below bottom of manhole cone.
 5. Fill gravity sanitary sewer pipe and manhole or pipe riser, when used, with water to point two and one-half feet (2-1/2 Ft) above highest point in gravity sanitary sewer pipe, house lead, or ground water table, whichever is highest.
 6. Allow water to stabilize for one hour (1 Hr) to two hours (2 Hrs). Take water level reading to determine drop of water surface, in inches, over one hour (1 Hr) period, and calculate water loss [one inch (1 In) of water in four feet (4 Ft) diameter manhole equals eight and twenty-two hundredths gallons (8.22 Gal)] or measure quantity of water required to keep water at same level. Loss shall not exceed that calculated from allowable leakage according to TABLE 4.1 WATER TEST ALLOWABLE LEAKAGE in this Section.
- D. Infiltration test: Ground water elevation must be not less than two feet (2 Ft) above highest point of gravity sanitary sewer pipe or service lead (house service).
1. Determine ground water elevation.
 2. Plug incoming pipes in upstream manhole.
 3. Insert calibrated ninety-degree (90°) V-notch weir in pipe on downstream manhole.
 4. Allow water to rise and flow over weir until it stabilizes.
 5. Take five (5) readings of accumulated volume over period of two hours (2 Hrs) and use average for infiltration. Average must not exceed that calculated for two hours (2 Hrs) from allowable leakage according to TABLE 4.1 WATER TEST ALLOWABLE LEAKAGE in this Section.
- E. Low Air Pressure Test: When using this test conform to ASTM C924 or ASTM F1417, as applicable, with holding time not less than that listed in TABLE 4.2 – TIME ALLOWED FOR PRESSURE LOSS FROM 5.0 PSI TO 4.0 PSI.
1. Air testing for sections of pipe shall be limited to lines less than thirty-six inch (36 In) average inside diameter.
 2. Lines thirty-six inch (36 In) average inside diameter and larger shall be tested at each joint. Minimum time allowable for pressure to drop from five pounds per square inch (5.0 psi) to four pounds per square inch (4.0 psi) during joint test shall be ten seconds (10 Sec), regardless of pipe size.
 3. For pipe sections less than thirty-six inch (36 In) average inside diameter:

- a. Determine ground water level.
 - b. Plug both ends of pipe.
 - c. After manhole-to-manhole section of gravity sanitary sewer main has been sliplined and prior to any service lines being connected to new liner, plug liner at each manhole with pneumatic plugs.
 - d. Pressurize pipe to five pounds per square inch (5.0 psi). See TABLE 4.2 – TIME ALLOWED FOR PRESSURE LOSS FROM 5.0 TO 4.0 PSI in this Section.
 - e. To determine air loss, measure time interval for pressure to drop to four pounds per square inch (4.0 psi). Time must exceed that listed in TABLE 4.2 – TIME ALLOWED FOR PRESSURE LOSS FROM 5.0 TO 4.0 PSI in this Section for pipe diameter and length. For sliplining, use diameter of carrier pipe.
- F. Retest: Repair and retest any section of pipe which fails to meet requirements.

3.5 TEST CRITERIA TABLES

- A. Exfiltration and Infiltration Water Tests: Refer to TABLE 4.1 WATER TEST ALLOWABLE LEAKAGE in this Section.
- B. Low Pressure Air Test:
 - 1. TABLE 4.2 – TIME ALLOWED FOR PRESSURE LOSS FROM 5.0 TO 4.0 PSI in this Section, are based on equation from Texas Commission on Environmental Quality (TCEQ) Design Criteria 317.2(a)(4)(B).

$$T = 0.0850(D)(K)/(Q)$$

- Where:
- T = time for pressure to drop one (1.0) pound per square inch gauge in seconds
 - K = 0.000419 DL, but not less than one (1.0)
 - D = average inside diameter in inches
 - L = length of line of same size pipe
 - Q = rate of loss, 0.0015 ft³/min./sq. ft. internal surface

- 2. Since K value of less than one (1.0) shall not be used, there are minimum testing times for each pipe diameter as given in TABLE 4.3 – MINIMUM TESTING TIMES FOR LOW PRESSURE AIR TEST in this Section.

Notes:

- 1. When two (2) sizes of pipe are involved, compute time by ratio of lengths involved.
- 2. Lines with twenty-seven inch (27 In) average inside diameter and larger may be air tested at each joint.
- 3. Lines with average inside diameter greater than thirty-six inches (36 In) shall be air tested for leakage at each joint.
- 4. If joint test is used, perform visual inspection of joint

immediately after testing.

5. For joint test, pipe is to be pressurized to four (4.0) psi greater than pressure exerted by groundwater above pipe. Once pressure has stabilized, minimum times allowable for pressure to drop from five (5.0) pounds per square inch to four (4.0) pounds per square inch shall be ten (10) seconds.

3.6 LEAKAGE TESTING FOR MANHOLES

- A. After completion of manhole construction, wall sealing, or rehabilitation, but prior to backfilling, test manholes for water tightness using hydrostatic or vacuum testing procedures.
- B. Plug influent and effluent lines, including service lines, with suitably sized pneumatic or mechanical plugs. Ensure plugs are properly rated for pressures required for test; follow manufacturer's safety and installation recommendations. Place plugs minimum of six inches (6 In) outside of manhole walls. Brace inverts to prevent lines from being dislodged when lines entering manhole have not been backfilled.
- C. Vacuum testing:
 1. Install vacuum tester head assembly at top access point of manhole and adjust for proper seal on straight top section of manhole structure. Following manufacturer's instructions and safety precautions, inflate sealing element to recommended maximum inflation pressure; do not over-inflate.
 2. Evacuate manhole with vacuum pump to ten inches (10 In) of mercury (Hg), disconnect pump, and monitor vacuum for time period specified in Table 4.3 VACUUM TESTING TIMETABLE in this Section.
 3. If drop in vacuum exceeds one inch of mercury(1 In/Hg) over specified time period tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.
- D. Perform hydrostatic exfiltration testing as follows:
 1. Seal wastewater lines coming into manhole with internal pipe plug. Then fill manhole with water and maintain it full for at least one hour (1 Hr).
 2. The maximum leakage for hydrostatic testing shall be twenty-five thousandths gallons (0.025 Gal) per foot diameter per foot of manhole depth per hour.
 3. If water loss exceeds amount tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

3.7 SMOKE TEST PROCEDURE FOR POINT REPAIRS

- A. Application: Perform smoke test to:
 1. Locate points of line failure for point repair.

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2. Determine when point repairs are properly made.
 3. Determine when service connections have been reconnected to rehabilitated sewer.
 4. Check integrity of connections to newly replaced service taps to liners and to existing private service connections.
- B. Limitations: Do not backfill service taps until completion of this test. Test only those taps in single manhole-to-manhole section at one (1) time. Keep number of open excavations to minimum.
- C. Preparation: Prior to smoke testing, give written notices to area residents no fewer than two days (2 D), nor more than seven days (7 D), prior to proposed testing. Also give notice to the City of Friendswood Police, Fire Departments and Public Works twenty-four hours (24 Hrs) prior to actual smoke testing.
- D. Isolate Section: Isolate manhole section to be tested from adjacent manhole sections to keep smoke localized. Temporarily seal annular space at manhole for sliplined sections.
- E. Smoke Introduction:
1. Operate equipment according to manufacturer's recommendation and as approved by the Project Manager.
 2. Conduct test by forcing smoke from smoke generators through gravity sanitary sewer main and service connections. Operate smoke generators for minimum of five minutes (5 Min).
 3. Introduce smoke into upstream and downstream manhole as appropriate. Monitor taps/connections for smoke leaks. Note sources of leaks.
- F. Repair and Retest: Repair and replace taps or connections noted as leaking and then retest. Taps and connections may be left exposed in only one (1) manhole-to-manhole section at time. When repair or replacement, testing or retesting, and backfilling of excavation is not completed within one (1) workday, properly barricade, and cover each excavation as approved by the Project Manager.
- G. Service Connections: On houses where smoke does not escape from plumbing vent stacks to confirm reconnection of sewer service to newly installed liner pipe, perform dye test to confirm reconnection has been made. Introduce dye into service line through plumbing fixture inside structure or sewer cleanout immediately outside structure and flush with water. Observe flow at service reconnection or downstream manhole. Detection of dye confirms reconnection.

PART IV: TABLES

4.1 – WATER TEST ALLOWABLE LEAKAGE

Diameter of Riser or Stack in Inches	Volume per Inch of Depth		Allowance Leakage*	
	Inch	Gallons	Pipe Size in Inches	Gal./Min. per 100 ft.
1	0.7854	0.0034	6	0.0039
2	3.1416	0.0136	8	0.0053
2.5	4.9087	0.0212	10	0.0066
3	7.0686	0.0306	12	0.0079
4	12.5664	0.0306	15	0.0099
5	19.6350	0.0544	18	0.0118
6	28.2743	0.1224	21	0.0138
8	50.2655	0.2176	24	0.0158
			27	0.0177
			30	0.0197
			36	0.0237
			42	0.0276
For other diameters, multiply square of diameters by value for 1" diameter.			Equivalent to 50 gallons per inch of inside diameter per mile per 24 hours.	
* Allowable leakage rate shall be reduced to ten gallons (10 Gal) per inch of inside diameter per mile per twenty-four hours (24 Hrs) when sewer is identified as located above twenty-five year (25 Yr) flood plain.				

4.2 TIME ALLOWED FOR PRESSURE LOSS FROM 5.0 PSI TO 4.0 PSI

Pipe Dia. In.	Min. Time mm:ss	Length for Min. Time	Time for Longer Length	Specification Time for Length (L) shown in MM:SS					
				100'	150'	200'	250'	300'	
6	5:40	398	0.8548	5:40	5:40	5:40	5:40	5:40	
8	7:33	298	1.5196	7:33	7:33	7:33	7:33	7:36	
10	9:27	239	2.3743	9:27	9:27	9:27	9:54	11:52	
12	11:20	199	3.4190	11:20	11:20	11:20	14:15	17:06	
15	14:10	159	5.3423	14:10	14:10	17:48	22:16	26:43	
18	17:00	133	7.6928	17:00	19:14	25:39	32:03	38:28	
21	19:50	114	10.4708	19:50	26:11	34:54	43:38	52:21	
24	22:40	99	13.6762	22:48	34:11	45:35	56:59	68:23	
27	25:30	88	17.3089	28:51	43:16	57:42	72:07	86:33	
30	28:20	80	21.3690	35:37	53:25	71:14	89:02	106:51	
33	31:10	72	25.8565	43:06	64:38	86:11	107:44	129:17	
Pipe Dia. In.	Min. Time mm:ss	Length for Min. Time	Time for Longer Length	Specification Time for Length (L) shown in MM:SS					
				350'	400'	450'	500'	550'	600'
6	5:40	398	0.8548	5:40	5:42	6:25	7:07	7:50	8:33
8	7:33	298	1.5196	8:52	10:08	11:24	12:08	13:56	15:12
10	9:27	239	2.3743	13:51	15:50	17:48	19:47	21:46	23:45
12	11:20	199	3.4190	19:57	22:48	25:39	28:30	31:20	34:11
15	14:10	159	5.3423	31:10	35:37	40:04	44:31	48:58	53:25
18	17:00	133	7.6928	44:52	51:17	57:42	64:06	70:31	76:56
21	19:50	114	10.4708	61:05	69:48	78:32	87:15	95:59	104:42
24	22:40	99	13.6762	79:47	91:10	102:34	113:58	125:22	136:46
27	25:30	88	17.3089	100:58	115:24	129:49	144:14	158:40	173:05
30	28:20	80	21.3690	124:39	142:28	160:16	178:05	195:53	213:41
33	31:10	72	25.8565	150:50	172:23	193:55	215:28	237:01	258:34

4.3 MINIMUM TESTING TIMES FOR LOW PRESSURE AIR TEST

Pipe Diameter (Inches)	Minimum Time (seconds)	Length of Pipe for Minimum Time (feet)	Time for Longer Length (seconds)
6	340	398	0.855 (L)
8	454	298	1.520 (L)
10	567	239	2.374 (L)
12	680	199	3.419 (L)
15	850	159	5.342 (L)
18	1020	133	7.693 (L)
21	1190	114	10.471 (L)
24	1360	99	13.676 (L)
27	1530	88	17.309 (L)
30	1700	80	21.369 (L)
33	1870	72	258.856 (L)

4.4 – VACUUM TESTING TIME TABLE

TIME ALLOWED FOR VACUUM LOSS FROM 10.0 Hg TO 9.0 Hg			
TIME IN SECONDS BY DIAMETER OF MANHOLES			
Manhole Depth in Feet	48" Diameter	60" Diameter	72" Diameter
8' and less	14	18	23
10	17	23	28
12	21	28	34
14	25	32	40
16	28	37	45
18	23	41	51
20	35	46	57
22	39	51	62
24	42	55	68
26	46	60	74
28	49	64	80
30	53	69	85

4.5 – PIPE VS. MANDREL DIAMETER

PIPE VERSUS MANDREL DIAMETER			
Material and Wall Construction	Nominal Size (Inches)	Average I.D. (Inches)	Minimum Mandrel Diameter (Inches)
PVC - Solid (SDR 26)6	6	5.764	5.476
	8	7.715	7.329
	10	9.646	9.162
PVC – Solid (SDR 35)12	12	11.737	11.150
	15	14.374	13.655
	18	17.629	16.748
	21	20.783	19.744
	24	23.381	22.120
	27	26.351	25.033
PVC – Truss	8	7.750	7.363
	10	9.750	9.263
	12	11.790	11.201
	15	14.770	14.032
PVC – Profile (ASTM F794)	12	11.470	11.153
	15	14.370	13.652
	18	17.650	16.768
	21	20.750	19.713
	24	23.500	22.325
	27	26.500	25.175
	30	29.500	28.025
	36	35.500	33.725
	42	41.500	39.425
HDPE – Profile	48	47.500	45.125
	18	18.000	17.100
	21	21.000	19.950
	24	24.000	22.800
	27	27.000	25.650
	30	30.000	28.500
	36	36.000	34.200
	42	42.000	39.900
	48	48.000	45.600
Fiberglass (Class SN-46)	54	54.000	51.300
	60	60.000	57.00
	12	12.85	11.822
	18	18.66	17.727
	20	20.68	19.646
	24	24.72	23.484
	30	30.68	29.146
	36	36.74	34.903
	42	42.70	40.565
48	48.76	46.322	
54	54.82	52.079	
60	60.38	57.361	

END OF SECTION