PG-021399

Avista Utilities
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AVISTA Utilities
Washington Water Power Division

November 20, 2002

Mr. Scott Rukke
WA Utilities and Transportation Commission
P.O. Box 47250
Olympia, WA 98504-7250

Re: Calculations and Drawings for Argonne Road Bridge PE in steel casing

Dear Mr. Rukke:

As per recent telephone conversations and email transmissions, please find enclosed herein for your reference, Avista's Construction Documents and Engineering Calculations for the Argonne Road Bridge Project in Spokane, Washington.

I look forward to visiting the project site with you, both in the coming months before the installation of our facilities on the bridge and during the actual installation of facilities by my chosen contractor (casing and hangers) and Avista Gas Crews.

If you have any questions, please contact me at (509) 495-8716.

Sincerely,

Randy K. Bareither
Gas Distribution Engineer
Avista Utilities

S-1321 (3-99)

SPOKANE COUNTY ROAD PROJECT NO. 2716

ARGONNE ROAD BRIDGE

11/8/02

① BRIDGE LENGTH : 339 FT 0 INCHES

② OPERATING MAOP : 60 PSIG (90 PSIG TEST PRESSURE)

③ MAX. ALLOWABLE OPER. PRESSURE: CALCULATED PER AVISTA STANDARDS

SECTION 2.13
PG 2/5
AVISTA GAS STDS

$$P_{MAX} = 0.32 \times 2S / (SDR-1)$$

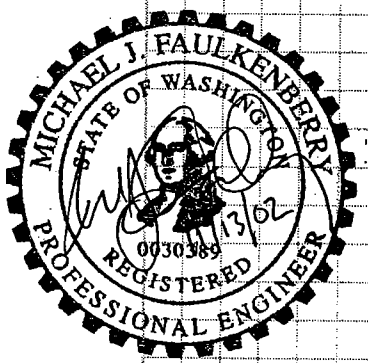
WHERE: S = 1000 PSIG (LONG-TERM HYDROSTATIC STRENGTH)
SDR = 11.5 (STD. DIMENSION RATIO)

$$P_{MAX} = 0.32(2)(1000)/(11.5-1) = 60.95 \text{ PSIG}$$

60.95 PSIG > 60 PSIG (MAOP) ∴ O.K.

④ PIPE CHOICES : PROPOSE 6" PE CARRIER W/IN 10" STEEL CASING

6" P.E. CARRIER PIPE (PLEXCO 2406)
- 0.576" w.t.
- 6.625" O.D.
- 5.404" I.D.
- $E = 88 \times 10^3$ psi (MODULUS OF ELASTICITY)
- $\alpha = 9 \times 10^{-5}$ in/in·°F (COEF. OF THERM. EXPANSION)
- $HDB_{140} = 1000$ psi (HYDROSTATIC DESIGN BASIS AT 140°F - WORST CASE)
- WEIGHT = 4.75 lb/FT



EXPIRES 7/13/04

10" STEEL CASING PIPE
- 0.25" w.t.
- 10.75" O.D.
- 10.25" I.D.
- GRADE B
- WEIGHT = 28.04 lb/ft.

TOTAL WEIGHT PER FOOT = 4.75 + 28.04 = 32.79 lb/ft.

⑤ HANGERS : PROPOSE LB+A ADJUSTABLE ROLL GUIDE (3B) HDG

WEIGHT = 27.7 lb
7/8" ROD
CAST IRON ROLLS W/ 7/8" ROLL AXLE, ADJUSTABLE SOCKETS & NUTS
MAX LOAD = 1730 lb

S-1321 (3-99)

SPOKANE COUNTY ROAD PROJECT NO. 2710

ARGONNE ROAD BRIDGE

11/8/02

⑥ THERMAL CONTRACTION CALCULATIONS & ASSOCIATED STRESSES

$$\delta = \frac{L T_D}{1000}$$

L - LENGTH OF PIPE (FT)

T_D - TEMP. DIFFERENCE (°F)

δ - CONTRACTION (INCHES)

[FROM AVISTA GAS STANDARDS SPEC. 2.13 PG. 3 OF 5]

$$\delta = \frac{(339 ft)(73°F - (-20°F))}{1000} = 31.5 \text{ inches}$$

ASSUME ENDS OF PIPE @ ABUTMENT ARE "FIXED" AND CONSEQUENTLY NO CONTRACTION WILL OCCUR. PIPE WILL THEREFORE BE UNDERGOING INTERNAL STRESSES.

$$\sigma_T = E \alpha \Delta T$$

[EQUATION (4), PG 26 (8/92) PLEXCO ENGINEERING MANUAL]

E - MODULUS OF ELASTICITY (psi)

α - COEF. OF THERMAL EXPANSION $\left(\frac{in}{in \cdot °F}\right)$

ΔT - TEMP CHANGE (°F)

σ_T = STRESS (psi)

$$\sigma_T = \left(88 \times 10^3 \frac{lbf}{in^2}\right)\left(9 \times 10^{-5} \frac{in}{in \cdot °F}\right)(73°F - (-20°F))$$

$$\sigma_T = 736.6 \text{ psi}$$

FROM TABLE I, Pg 3 (8/92) - "LONG TERM STRESS RATINGS & SVC TEMPS" PLEXCO ENGINEERING MANUAL FOR PLEXCO 2406:

HDB_{140} = 1000 psi (Hydrostatic Design Basis @ 140°F)

1000 psi > 736.6 psi SF = 1.36

∴ INDUCED STRESS O.K.

S-1321 (3-99)

SPOKANE COUNTY ROAD PROJECT NO. 2710
ARGONNE ROAD BRIDGE
11/8/02

⑦ HANGER ROD : PROPOSE 7/8" ϕ, COARSE SERIES, LB&A (12B)

96,500 psi YIELD STRENGTH
101,000 psi TENSILE STRENGTH
MAX LOAD = 3770 lb
WEIGHT = 1.71 lb/FT.

⑧ HANGER SPACING CALCULATIONS

FROM PREVIOUS EXPERIENCE GUESS 15 Ft. SPACING
339 ft BRIDGE ⟶ 15' SPACING ⟶ 22 HANGERS

TOTAL WEIGHT OF PIPE, HANGERS + MISC.

(32.79 lb/ft)(339 ft) = 11,116 lb (PE PIPE & CASING)
(27.7 lb)(22 HANGERS) = 609 lb (HANGERS)
11,725 lb

WEIGHT/HANGER ⟶ 11,725 lb/22 = 533 lb/HANGER

$SF = \frac{1773\ lb/HANGER}{533\ lb/HANGER} = 3.25$ O.K.

⑨ CONCRETE INSERTS & NUTS : PROPOSE ERICO (MICHIGAN HANGER)

MOD # 355, 7/8", 1200 lb MAX LOAD (INSERT)
MOD # 355N, 7/8", 1200 lb MAX LOAD (NUT)

$SF = \frac{(44)(1200\ lb)}{11,725 + (1.71(3.5)(33))} = \frac{52,800\ lb}{11,923\ lb} = 4.43$ O.K.

(11,725 ↑ PIPE + HANGERS WEIGHT; 1.71(3.5)(33) ↑ ROD WEIGHT)

⑩ HANGER ROD STRENGTH CALCULATIONS

$\sigma_T = W/A_t$ W - WEIGHT ON EACH ROD (11,923/44 = 271 lb)
A_t - TENSILE STRESS AREA (0.462" FROM 8th EDITION, SHIGLEY, PG 230)

$\sigma_T = 271\ lb/0.462" = 587\ psi$

$SF = 101,000\ psi / 587\ psi = 172$ ∴ O.K.

S-1321 (3-99)

SPOKANE COUNTY ROAD PROJECT NO. 2710
ARGONNE ROAD BRIDGE
11/8/02

(11) NUT SHEAR CALCULATIONS

PROPOSE HEAVY HEX NUTS, 7/8", GRADE A563, YIELD = 60,000 PSI, nut height (h) = 0.833" (MACHINERY'S HDBK)
MAJOR DIAMETER (d) = 0.875"

$$\tau = \frac{2F}{\pi d h}$$ (SHIGLEY, 3rd ED, EQ 6-8, Pg 237)

F - WEIGHT ON NUT (2711b)

$$\tau = \frac{2(2711b)}{\pi(0.875in)(0.833in)} = 237psi$$

$$SF = 60{,}000psi / 237psi = 253 \quad O.K.$$

(12) BEARING STRESS IN NUT THREADS CALCULATIONS

$$\sigma = \frac{-4pF}{\pi h(d^2 - d_r^2)}$$

p - thread pitch = 1/THREADS PER INCH (N)
h - nut height (0.833")
d - major diameter (0.875")
d_r - minor diameter
F - WEIGHT ON NUT (2711b)

$p = 1/N = 1/9 = 0.1111$ (FROM TABLE 6.2, SHIGLEY, 3rd EDITION)

$$d_r = \sqrt{\frac{4Ar}{\pi}} = \sqrt{\frac{4(.419)}{\pi}} = .730\,in$$

$$\sigma = \frac{-4(.1111)(2711b)}{\pi(0.833)(.875^2 - .730^2)} = -198psi$$

$SF = 60{,}000/198 = 303$ ∴ O.K.

(13) FINAL PROPOSAL

- 6" PE CARRIER PIPE, 11.5 DR, 0.576" w.t.
- 10" STEEL CASING PIPE, .250" w.t.
- LB+A 10" ADJUSTABLE ROLL GUIDE @ 15' SPACING
- 7/8" ROD, CONTINUOUS THREAD
- LATERAL RESTRAINT OF PIPE PER DRAWINGS
- ERICO CONCRETE INSERT (#355)
- ERICO CONCRETE INSERT NUT (#355N)

Design Formulas

The maximum pressure allowed for plastic pipe is determined in accordance with the following formula found in D.O.T. Section 192.121:

$$P = .32 \times 2S \times t/(D - t)$$
$$P = .32 \times 2S/(SDR - 1)$$

Where:
- P = Design pressure in PSIG, (AVISTA max: 60 PSIG)
- S = Long term hydrostatic strength in PSI. Use 1250 PSI (for pipe operating at less than 100°F); 1000 PSI (for pipe operating at less than 140°F but over 100°F)
- t = minimum wall thickness in inches
- D = specified outside diameter in inches
- SDR = standard dimension ratio, the ratio of the average specified outside diameter to the minimum specified wall thickness

The following sizes and wall thicknesses of polyethylene plastic pipe are approved for use. Use of other sizes and wall thickness should be reviewed and approved by Gas Engineering:

	NOMINAL	POLYETHYLENE PIPE DIMENSIONS					
	SIZE IN.	SDR*	MIN. WALL THICKNESS, IN.	AVERAGE O.D. IN.	AVERAGE I.D. IN.	WEIGHT LBS/FT.	STD. LENGTH, FT.
	1/2 CTS (5/8 OD)	7	0.090	0.625	0.439	0.06	1000 COIL
	3/4 IPS	11	0.095	1.050	0.860	0.10	500 COIL
	1-1/4 IPS	10	0.166	1.660	1.302	0.34	500 COIL
	2 IPS	11	0.216	2.375	1.917	0.63	500 COIL
	3 IPS	11.5	0.307	3.500	2.851	1.38	500 COIL 40 STRAIGHT
	4 IPS	11.5	0.395	4.500	3.670	2.17	40 STRAIGHT**
	6 IPS	11.5	0.576	6.625	5.404	4.75	40 STRAIGHT**

* SDR - Standard dimension ratio is calculated by dividing the average O.D. of the pipe by the minimum wall thickness in inches.

** NOTE - Coiled 4" IPS and 6" IPS pipe may be used; if an approved pipe straightener is employed.

Pressure/ Temperature Limitations

Under normal conditions, buried plastic pipe would not be exposed to a temperature of 100°F or more. The only place where plastic pipe would normally be subjected to a temperature greater than 100°F would be in the plastic pipe service risers encased in steel. Approved prefabricated service risers are designed to permit operating at 60 psig, at a temperature of up to 140°F.

Plastic pipe shall not be used where it could be exposed to a temperature of 140°F or higher.

Above Ground

Plastic pipe shall not be used in above-ground locations except when encased in a steel riser serving a meter set or for temporary emergency situations.

Plastic pipe shall not be installed where it would be exposed in a pit, vault or box, except in a valve box that is installed for a plastic valve.

Table I Time and Temperature Elastic Modulus

Plexco/Spirolite PE3408 - Typical Elastic Modulus, 10^3 psi								
Duration	Temperature, °F							
	-20	0	40	60	73	100	120	140
Instantaneous	300.0	260.0	215.0	151.0	110.0	100.0	83.1	72.8
10 h	156.8	135.9	112.4	78.9	57.5	52.3	43.4	38.1
100 h	139.6	121.0	100.1	70.3	51.2	46.5	38.7	33.9
1000 h	119.2	103.3	85.4	60.0	43.7	39.7	33.0	28.9
1 y	103.6	89.8	74.3	52.2	38.0	34.5	28.7	25.1
10 y	86.2	74.7	61.8	43.4	31.6	28.7	23.9	20.9
50 y	76.9	66.7	55.1	38.7	28.2	25.6	21.3	18.7
Plexco/Spirolite PE2406 - Typical Elastic Modulus, 10^3 psi								
Duration	Temperature, °F							
	-20	0	40	60	73	100	120	140
Instantaneous	240.0	210.0	132.6	107.3	88.0	80.0	66.5	58.2
10 h	125.5	109.8	69.3	56.1	46.0	41.8	34.8	30.4
100 h	111.8	97.8	61.8	50.0	41.0	37.3	31.0	27.1
1000 h	95.5	83.5	52.7	42.7	35.0	31.8	26.4	23.1
1 y	82.9	72.5	45.8	37.1	30.4	27.6	23.0	20.1
10 y	69.0	60.4	38.1	30.8	25.3	23.0	19.1	16.7
50 y	61.6	53.9	34.1	27.6	22.6	20.5	17.1	14.9

(Nominal values based on ASTM D 638 testing of molded material specimens.)

An end restrained pipe, either laid on the surface or in a pipe rack, will deflect laterally with temperature change. Lateral deflection may be determined from

$$y = L\sqrt{\frac{\alpha \Delta T}{2}} \qquad (1)$$

where

y = lateral deflection, in
L = distance between points, in
α = thermal expansion coefficient, in/in/°F
ΔT = temperature change, °F

A long, semi-restrained pipe run will snake to either side of the run centerline. Total deflection is

$$Y_T = 2(\Delta y) + D \qquad (2)$$

where

Y_T = total deflection, in
D = pipe outside diameter, in

Allowable distance between restraining points is dependent upon pipe deflection strain. Typically, 5% long term strain is a conservative allowance. The distance between restraining points may be determined by

$$L = \frac{0.98 D \sqrt{\Delta T}}{\epsilon} \qquad (3)$$

where

ϵ = pipe wall strain, %

2. STRESS RATED MATERIALS

Table I Long Term Stress Ratings and Service Temperatures

Property	ASTM Standard	PLEXCO PE3408	PLEXCO PE2406
HDB at 73°F HDB at 140°F	D 2837 D 2837	1600 psi 800 psi	1250 psi 1000 psi
Maximum Recommended Temperature for Pressure Service	--	140°F	140°F
Maximum Recommended Temperature for Non-Pressure Service	--	180°F	180°F

(The information presented in Table I applies to Plexco/Spirolite materials, and may not be applicable to products from other manufacturers.)

Plexco/Spirolite polyethylene pipes are manufactured using polyethylene materials that have been evaluated for long term performance under mechanical stress. This is because pipes are durable goods that are expected to perform for many, many years.

In North America, the recognized method for determining the long term performance of thermoplastic materials under stress is ASTM D 2837, Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

The hydrostatic design basis, HDB, for a thermoplastic material is the long term tensile stress at a specific temperature, that the material can be expected to withstand for 100,000 hours.

For polyethylene materials, ASTM D 2837 requires supplemental validation testing against failure by cracking. This is a critical requirement, because when polyethylene is placed under long term mechanical stress, it fails by cracks growing slowly through the material, a process called "slow crack growth". The supplemental validation requirement in D 2837 verifies that long term performance can be expected when continuous mechanical stress within the HDB rating is applied.

Without long term material evaluation, it is impossible to project how long a product may last. Only materials that have been evaluated for long term performance under stress can be expected to provide long term service.

STEEL PIPELINE DATA TABLE

NOM. PIPE SIZE	WALL THICKNESS		DIMENSIONS			WEIGHTS		CIRCUMFERENCE		AREAS		DESIGN PROPERTIES			VOLUME	
	IRON PIPE SIZE	SCH. NO.	OUTSIDE DIA.	INSIDE DIA.	WALL THICKNESS	PLAIN END PIPE	WATER IN PIPE	EXTERNAL	INTERNAL	CROSS-SECTIONAL FLOW	CROSS-SECTIONAL METAL	MOMENT OF INERTIA (I)	SECTION MODULUS	RADIUS OF GYRATION	INSIDE PIPE	
IN			IN	IN.	IN.	LB. PER FT	LB. PER FT.	IN.	IN.	IN^2	IN^2	IN^4	IN^3	IN.	$FT.^3$ PER FT.	GAL. PER FT.
3/4	STD.	40	1.050	.824	.113	1.131	.231	3.299	2.589	.5333	.3326	.0370	.0705	.3337	.0037	.0277
	XS	80	1.050	.742	.154	1.474	.187	3.299	2.331	.4324	.4335	.0448	.0853	.3214	.0030	.0225
1	STD.	40	1.315	1.049	.133	1.679	.375	4.131	3.296	.8643	.4939	.0873	.1328	.4205	.0060	.0449
	XS	80	1.315	.957	.179	2.172	.312	4.131	3.007	.7193	.6388	.1056	.1606	.4066	.0050	.0374
1 1/4	STD.	40	1.660	1.380	.140	2.273	.648	5.215	4.335	1.4957	.6685	.1947	.2346	.5397	.0104	.0777
	XS	80	1.660	1.278	.191	2.997	.556	5.215	4.015	1.2828	.8815	.2418	.2913	.5237	.0089	.0666
1 1/2	STD.	40	1.900	1.610	.145	2.718	.882	5.969	5.058	2.0358	.7995	.3099	.3262	.6226	.0141	.1058
	XS	80	1.900	1.500	.200	3.631	.766	5.969	4.712	1.7671	1.0681	.3912	.4118	.6052	.0123	.0918
2	STD.	40	2.375	2.067	.154	3.65	1.45	7.461	6.494	3.356	1.075	.666	.561	.787	.0223	.1743
	XS	80	2.375	1.939	.218	5.02	1.28	7.461	6.092	2.953	1.477	.868	.731	.766	.0205	.1534
3			3.500	3.218	.141	5.06	3.52	10.996	10.104	8.129	1.492	2.102	1.201	1.187	.0564	.4222
			3.500	3.188	.156	5.57	3.46	10.996	10.015	7.982	1.639	2.296	1.312	1.184	.0554	.4140
			3.500	3.124	.188	6.65	3.32	10.996	9.814	7.665	1.956	2.691	1.538	1.173	.0532	.3982
	STD.	40	3.500	3.068	.216	7.58	3.20	10.996	9.638	7.393	2.228	3.017	1.724	1.164	.0513	.3840
	XS	80	3.500	2.900	.300	10.25	2.86	10.996	9.111	6.605	3.016	3.894	2.225	1.136	.0459	.3431
4		-	4.500	4.188	.156	7.24	5.97	14.137	13.157	13.775	2.129	5.028	2.235	1.537	.0957	.7155
		-	4.500	4.124	.188	8.66	5.79	14.137	12.956	13.358	2.547	5.930	2.636	1.526	.0928	.6939
	STD.	40	4.500	4.026	.237	10.79	5.52	14.137	12.648	12.730	3.174	7.233	3.214	1.510	.0884	.6613
	XS	80	4.500	3.826	.337	14.98	4.98	14.137	12.020	11.497	4.407	9.610	4.271	1.477	.0798	.5972
6		-	6.625	6.313	.156	10.78	13.6	20.813	19.829	31.30	3.17	16.59	5.01	2.29	.2174	1.6260
		-	6.625	6.281	.172	11.85	13.4	20.813	19.732	30.96	3.49	18.16	5.48	2.28	.2152	1.6096
			6.625	6.249	.188	12.92	13.3	20.813	19.632	30.67	3.80	19.71	5.95	2.28	.2130	1.5932
	STD.	40	6.625	6.065	.280	18.97	13.5	20.813	19.054	28.89	5.58	28.14	8.50	2.25	.2006	1.5008
	XS	80	6.625	5.761	.432	28.57	13.3	20.813	18.099	26.07	8.40	40.49	12.22	2.19	.1810	1.3541
8			8.625	8.281	.172	15.53	23.3	27.096	26.018	53.86	4.57	40.81	9.46	2.99	.3740	2.7979
			8.625	8.248	.188	16.94	23.2	27.096	25.915	53.44	4.98	44.37	10.29	2.98	.3711	2.7763
			8.625	8.219	.203	18.30	23.0	27.096	25.821	53.06	5.38	47.64	11.05	2.98	.3685	2.7562
			8.625	8.187	.219	19.66	22.8	27.096	25.720	52.64	5.78	51.12	11.85	2.97	.3656	2.7347
			8.625	8.063	.281	25.07	22.1	27.096	25.331	51.05	7.37	64.18	14.86	2.95	.3546	2.6524
	STD.	40	8.625	7.951	.322	28.55	21.7	27.096	25.073	50.03	8.40	72.49	16.21	2.94	.3474	2.5988
	XS	80	8.625	7.625	.500	43.39	19.8	27.096	23.955	45.66	12.76	105.72	24.51	2.88	.3171	2.3721
10	-		10.750	10.374	.188	31.21	36.6	33.772	32.597	84.52	6.24	87.01	16.19	3.73	.5870	4.3909
			10.750	10.344	.203	23.87	36.4	33.772	32.497	84.04	6.73	93.57	17.41	3.73	.5836	4.3654
	-		10.750	10.312	.219	24.63	36.2	33.772	32.396	83.52	7.25	100.48	18.69	3.72	.5800	4.3396
		20	10.750	10.250	.250	28.04	35.8	33.772	32.201	82.52	8.25	113.71	21.16	3.71	.5730	4.2885
	STD.	40	10.750	10.020	.365	40.48	34.2	33.772	31.479	78.85	11.91	160.73	29.90	3.67	.5476	4.0963
	XS	60	10.750	9.750	.500	54.74	32.4	33.772	30.631	74.66	16.10	211.95	39.43	3.63	.5185	3.8785
12			12.750	12.344	.203	27.2	52.0	40.055	38.780	119.9	7.99	157.2	24.7	4.43	.8326	6.2281
			12.750	12.312	.219	29.3	51.6	40.055	38.679	119.1	8.62	169.3	26.5	4.43	.8268	6.1847
		20	12.750	12.250	.250	33.4	51.1	40.055	38.485	117.2	9.82	191.8	30.1	4.42	.8185	6.1225
			12.750	12.188	.281	37.4	50.6	40.055	38.290	116.7	11.01	214.0	33.6	4.41	.8104	6.0619
			12.750	12.126	.312	47.4	50.0	40.055	38.095	115.5	12.19	235.9	37.0	4.40	.8020	5.9992
	STD.		12.750	12.000	.375	49.6	49.0	40.055	37.699	113.1	14.58	278.3	43.8	4.38	.7854	5.9752
	XS		12.750	11.750	.500	65.4	47.0	40.055	36.914	108.4	19.24	361.5	56.7	4.33	.7530	5.6329
16			16.00	15.562	.219	36.9	82.4	50.265	48.889	190.2	10.86	338.0	42.3	5.58	1.3208	9.8796
		10	16.00	15.500	.250	42.0	81.8	50.265	48.695	188.7	12.37	384.0	48.0	5.57	1.3104	9.8008
			16.00	15.435	.281	47.0	81.1	50.265	48.500	187.2	13.88	429.0	53.6	5.56	1.2999	9.7239
		20	16.00	15.376	.312	52.0	80.5	50.265	48.305	185.7	15.38	473.0	59.2	5.55	1.2895	9.6460
	STD.	30	16.00	15.250	.375	63.0	79.2	50.265	47.909	182.7	18.41	562.0	70.3	5.53	1.2684	9.4885
	XS	40	16.00	15.000	.500	83.0	76.6	50.265	47.124	176.7	24.35	732.0	91.5	5.48	1.2272	9.1800
18		10	18.000	17.500	.250	47.0	104.2	56.549	54.978	240.5	13.94	549.0	61.0	6.28	1.6703	12.4950
			18.000	17.438	.281	53.0	103.5	56.549	54.783	238.8	15.64	614.0	68.2	6.27	1.6585	12.4065
			18.000	17.375	.312	59.0	102.5	56.549	54.585	237.1	17.36	679.0	75.5	6.25	1.6465	12.3160
	STD.		18.000	17.250	.375	71.0	101.3	56.549	54.192	233.7	20.78	807.0	89.6	6.23	1.6230	12.1405
	XS		18.000	17.000	.500	93.0	98.4	56.549	53.407	227.0	27.49	1053.0	117.0	6.19	1.5763	11.7912
20		10	20.000	19.500	.250	53.0	129.4	62.832	61.261	298.8	15.51	756.0	75.6	6.98	2.0739	15.5142
			20.000	19.438	.281	59.0	128.6	62.832	61.066	296.8	17.41	846.0	84.6	6.97	2.0608	15.4157
			20.000	19.376	.312	66.0	127.8	62.832	60.872	294.9	19.30	935.0	93.5	6.96	2.0476	15.3175
			20.000	19.312	.344	78.0	126.9	62.832	60.670	292.9	21.24	1026.0	102.6	6.95	2.0341	15.2154
	STD.	20	20.000	19.250	.375	79.0	126.1	62.832	60.476	291.0	23.12	1113.0	111.3	6.94	2.0211	15.1189
			20.000	19.188	.406	85.0	125.3	62.832	60.281	289.2	24.99	1200.0	120.0	6.93	2.0081	15.0206
	XS	30	20.000	19.000	.500	104.0	122.9	62.832	59.690	283.5	30.63	1457.0	145.7	6.90	1.9689	14.7288
22		10	22.000	21.500	.250	58.0	157.4	69.115	67.544	363.1	17.18	1010.0	91.8	7.69	2.5215	18.8610
			22.000	21.438	.281	65.0	156.4	69.115	67.349	361.0	19.17	1131.0	102.8	7.68	2.5067	18.7511
			22.000	21.376	.312	72.0	155.5	69.115	67.155	358.9	21.26	1250.0	113.7	7.67	2.4922	18.6428
	STD.	20	22.000	21.250	.375	87.0	153.7	69.115	66.759	354.7	25.48	1490.0	135.4	7.65	2.4629	18.4237
	XS	30	22.000	21.000	.500	115.0	150.1	69.115	65.973	346.4	33.77	1952.0	177.5	7.60	2.4053	17.9926

CASING PIPE SPECIFICATIONS FOR PLASTIC (POLYETHYLENE) CARRIER PIPE	
Nom. Dia. of Plastic Carrier Pipe (in.)	Max. Suggested Casing Size* (in.)
1/2	2
3/4	2
1 1/4	3
2	4
3	6
4	8
6	10

*NOTES:
(1) Maximum suggested sizes are given to prevent damage to plastic carrier pipe should water leak into casing and freeze.
(2) Casing specifications for steel casings apply as shown in the previous table.
(3) PVC plastic casing must be gray Schedule 40 for size 2" through 6" and Schedule 80 for sizes 8" and above.

Casing Specifications

Plastic PVC casing may not be used for steel carrier pipeline. Plastic PVC casing inhibits the ability to cathodically protect the steel carrier pipeline. Plastic PVC casing may be used for polyethylene carrier pipeline if it provides sufficient strength to withstand all anticipated stresses due to overburden, bending, torsion, and temperature change and is approved by permitting agency.

It is preferred that casing be bare, but not mandatory.

Casing pipe should be butt welded with full circumferential welds to similar quality as the carrier pipeline.

Casings shall be seamless, ERW or DSAW welds, but need not meet specifications for carrier pipe. "Casing grade quality pipe" is preferred as it is lower in cost.

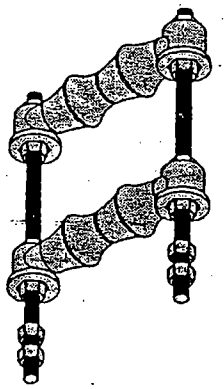
Casings designed for railroad crossings shall be per drawing B-33947, Sheet 1 of 2. Casings designed for state or interstate highway crossings shall be per drawing B-33947, Sheet 2 of 2.

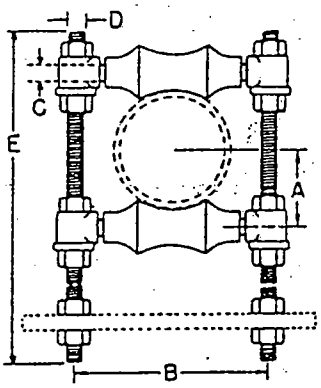
Vent pipe shall be painted above ground. Vent pipe must not contact steel carrier pipeline. Vent shall be installed so as to prevent water or other deleterious materials from entering vent opening.

Care must be taken to keep moisture from filling the casing. Normally, use of an approved end seal will keep the carrier pipeline dry and the ends free of debris. Although crossings should not be located where a freeway or expressway is in a depressed location, when this is unavoidable, additional measures may be taken to keep carrier pipeline dry. Contact Gas Engineering for advice in using additional sealing methods.

For steel carrier pipelines, casing insulators should be installed with minimum 5 feet separation. Close spacing prevents grounding of steel carrier pipeline to casing.

ADJUSTABLE ROLL GUIDE





ADJUSTABLE ROLL GUIDE INCLUDES:
4 ADJUSTABLE SOCKETS
2 ROLL AXEL
2 VERTICAL THREADED RODS
12 HEX NUTS
2 CAST IRON ROLLS (OMIT WHEN ORDERING NON-CONDUCTIVE ROLLERS)

SPECIFICATIONS MAY VARY - All Dimensions in Inches

Pipe Size	A	*B	C	Rod Size D	E	Socket No.	Max. Load lbs.	Wt. lbs./ea.
2	1 9/16	4 1/8	3/8	3/8	12	#1-3/8	600	2.15
2 ½	1 7/8	4 7/8	½	½	14	#2-1/2	660	4.02
3	2 3/16	5 ½	½	½	14	#2-1/2	700	4.34
3 ½	2 ½	6 1/8	½	½	14	#2-1/2	750	4.48
4	2 3/4	6 3/4	½	5/8	18	#3-1/2	750	6.73
5	3 7/16	8 1/16	5/8	5/8	18	#3-5/8	750	8.95
6	4	9 9/16	3/4	3/4	24	#4-3/4	1070	14.59
8	5 1/4	11 15/16	7/8	7/8	24	#5-7/8	1350	24.33
10	6 1/4	14 1/16	7/8	7/8	30	#5-7/8	1730	27.7
12	7 7/16	15 13/16	1	7/8	30	#5-1	2400	39.62
14	8 5/16	17 3/4	1 1/8	1	36	#6-1 1/8	3130	57.61
16	9 3/8	19 3/4	1 1/4	1	36	#6-1 1/4	3970	87.57
18	10 3/8	21 7/8	1 1/4	1	42	#7-1 1/4	4200	99.54
20	11 ½	24 1/4	1 1/4	1 1/4	42	#8-1 1/4	4550	131.82
24	13 13/16	28 5/8	1 1/2	1 1/2	42	#9-1 ½	6160	219.74

HWARG3B

***Axle lengths may affect B dimension. Contact supplier before drilling holes**

Bridge Crossings State and federal regulations are starting to allow plastic pipe to be installed on bridges in steel casings. This is being permitted only by waiver for each application. For this reason, Gas Engineering shall design all PE bridge crossings and negotiate requirements with state and federal regulators.

Plastic Under Waterways Plastic pipe should not be installed under a navigable waterway or in a waterway susceptible to scouring or migration. Steel should be used in these applications as it is less susceptible to wash-out.

Clearances Each plastic pipeline and foreign utility crossing shall be installed with 12-inch minimum radial (non-longitudinal) separation. If this clearance cannot be maintained, the pipeline must be protected from damage that might result from proximity to the other structure.

Each plastic pipeline, <u>including services</u>, should be installed with a 5-foot minimum longitudinal separation from sewer utility pipelines or storm drains or at further distances as specified by the appropriate regulating agency. Any variance from this separation must be approved by Gas Engineering.

No plastic pipelines, <u>including services</u>, shall be installed through, above or below septic drain fields without approval of Gas Engineering. Septic and sewer systems afford an easy path for gas migration should a leak <u>every</u> occur.

Each plastic pipeline, <u>excluding services</u>, should be installed with 3-foot minimum longitudinal separation from water utility pipelines or at further distances specified by the appropriate regulating agency. When necessary, natural gas <u>services</u> may be installed within 3-foot, but not less than 1 foot longitudinal separation.

Plastic pipe may be installed in joint trench with utilities other than those mentioned above at a longitudinal separation not less than 12 inches.

Plastic pipe shall not be installed closer than 10 feet of a steam or hot water pipeline and in general should not be installed in an area where there exists steam or a hot water distribution system.

Plastic mains and services located adjacent to the buildings should be done so with a concern for future maintenance and an awareness of the possibility of gas becoming trapped under the building should a leak occur.

Pipe must be designed and installed so it and associated fittings will be free of tensile loading as a result of temperature change. Allowance must be made for thermal contraction when plastic pipe is installed on a warm day; otherwise pipe will be in tension when it cools.

Thermal Contraction Amount of thermal contraction can be determined by the following formula:

$$\text{CONTRACTION (INCHES)} = \frac{T_D \times L}{1000}$$

Where T_D = temperature drop (°F)

L = length of plastic pipe (ft.)

Pipelines joined by heat fusion, flanges, or fully restrained mechanical joints, can transmit significant thermal contraction loads to end structures or appurtenances if the pipe is allowed to contract to a straight line between anchor points. The tensile stress between end points is given by

$$\sigma_T = E \alpha \Delta T \qquad (4)$$

where

σ_T = stress, psi
E = elastic modulus, psi

Each end point will see half of this stress. The elastic modulus is both time and temperature dependent. See Table I.

The coefficient of thermal expansion for Plexco/Spirolite polyethylene materials is 9.0 x 10^{-5} in/in/°F. An approximate expansion allowance for pipes is 1/10/100, that is, 1 in for each 10°F change for each 100 ft of pipe. This is a significant length change compared to other piping materials.

Controlling Expansion and Contraction

For unrestrained PLEXCO piping systems, the designer may choose to provide end point anchor structures. This provides straight pipe, but requires pipeline anchoring structures capable of handling potentially high thermal contraction stresses. Or, the designer may provide expansion loops. Expansion loops reduce end point anchor structural requirements, but require more space. Expansion joints are not recommended because expansion allowance is frequently insufficient for polyethylene, and, especially in pressure service, polyethylene may not provide sufficient longitudinal thrust to compress the expansion joint.

Traditional expansion loop designs use fittings to create an offset and return to the original piping run. However, long runs of flexible polyethylene pipe would rather deflect laterally than push, so traditional expansion loop designs are not particularly effective. As well, rigid, large diameter fabricated fittings should be protected from the dynamic flexural stresses imposed by expansion loops. Therefore, traditional fitting style expansion loops should be limited to small diameter piping.

An effective flexible pipe expansion loop system employs the pipe's natural tendency to deflect laterally, and its high strain tolerance. Lateral deflection expansion loops are recurrent "S-curves" (snaking) along the piping runs that provide an initial lateral deflection, and allow pipe temperature changes to result in greater or lesser lateral deflection.

Surface and rack supported pipe systems designed with lateral deflection expansion loops must provide sufficient width allowance for lateral pipe deflection.

An initial deflection should be provided so the pipe does not contract to a straight line at minimum expected temperature. At the time of installation, the anticipated temperature change from installation temperature to minimum temperature should be determined. Using this temperature change and the distance between points, determine lateral deflection, and install the pipe with this lateral deflection plus the minimum lateral deflection specified by the designer.

Above grade piping may also be hung from support rods. Hangers must allow for lateral deflection with sufficient support rod length,

Technical Information

THREADED HANGER RODS

Threaded Rod Size	5/16 - 18	3/8 - 16	1/2 - 13	5/8 - 11	3/4 - 10	7/8 - 9	1 - 8
Threaded Rod Stress Area (sq. in.)	0.0524	0.0775	0.1419	0.226	0.334	0.462	0.606
Yield Load (lb)	5080	6320	9720	14800	31060	42580	59080
Yield Strength 0.2% Offset (psi)	97000	81500	68500	65500	93000	96500	97500
Tensile Load (lb)	5290	6660	10640	16160	34070	46680	61810
Tensile Strength (psi)	101000	86000	75000	71500	102000	101000	102000
% Elongation in 1"	20	19	22	25	16	17	17
% Reduction of Area	58	68	66	72	47	48	45
Rockwell Hardness "B" Scale	96.0	99.0	88.5	93.0	95.5	94.0	94.5

Note:
The yield strength, tensile strength, % elongation & % reduction of area reported to the left were determined by testing machined test specimens in accordance with ASTM A370.

Hardness testing was performed in accordance with ASTM E18. The yield load & tensile load were calculated from this yield strength & tensile strength using the stress areas (cross-sectional area) for each threaded rod size.

Technical Information

MSS LOAD RATINGS OF THREADED HANGER RODS MATERIALS - ASTM 36, A575 GR 1020

Nominal Rod Diameter	Root Area of Thread	Max. Safe Load At Rod Temp. of 650°F (343°C)
3/8	0.068	610
9.5	43.8	275
1/2	0.126	1130
12.7	81.3	510
5/8	0.202	1810
15.9	130.3	820
3/4	0.302	2710
19	194.8	1230
7/8	0.419	3770
22.2	270.3	1710
1	0.552	4960
25.4	356.1	2250
1-1/4	0.889	8000
31.8	573.5	3630
1-1/2	1.293	11630
38.1	834.2	5280
1-3/4	1.744	15690
44.4	1125	7120
2	2.292	20690
50.8	1479	9390
2-1/4	3.021	27200
57.2	1949	12350
2-1/2	3.716	33500
63.5	2397	15200

Note:
Tabulated loads are based on an allowable tensile stress of 12,000 psi (82.7 MPa) reduced by 25% resulting in 9,000 psi (62 MPa). (12,000 psi allows for the interchangeability of the referenced rod materials.) (The 25% reduction is to allow for normal installation and service conditions.)

12B

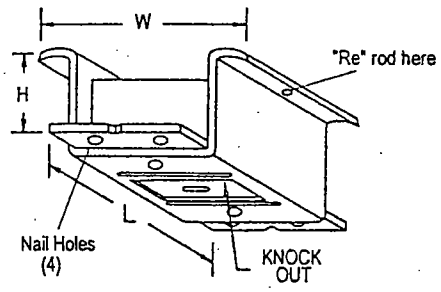
CONTINUOUS THREADED ROD

Rod Size A	B = Feet	Max. Recom. Load / lbs.		Weight Per C Feet
		650°F	750°F	
1/4	6 and 10	240	215	12
3/8	6 and 10	610	540	30
1/2	6 and 10	1130	1010	54
5/8	6 and 10	1810	1610	85
3/4	6 and 10	2710	2420	124
7/8	6 and 10	3770	3360	171
1	6 and 10	4960	4420	223

HWCTR128

Model #355

Steel Concrete Insert



Through 6" pipe size

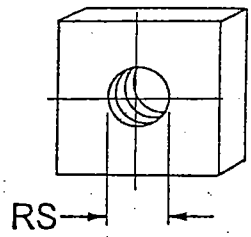
APPLICATION: As a structural attachment in all grades of concrete. Knockout keeps interior empty during pour. Allows for horizontal rod adjustment up to 1-1/4".

NOTE: Installation: Place knockout side down on concrete form and nail in place. Wire 12" piece of #4 reinforcing rod on both sides. After concrete pour, knockout can be removed with a screw driver. Use with Model #355N Insert Nut (for UL Listing), or Models: #Nut, #SPRA, #SPRC strut nuts. Rod should be threaded thru the nut until it tightens against the top of the insert.

c UL us LISTED

Catalog No.	Max. Rod Size	H	W	L	Max. Pipe size	Max. Recom. load size	Finish*
3550000EG	7/8	1-5/8	3	3	10	1200	EG
3550000PL	7/8	1-5/8	3	3	10	1200	PL

Conforms With: Federal Specification **WW-H-171** (Type 19), Manufacturers Standardization Society **ANSI/MSS-SP-58** (Type 18); install in accordance with **ANSI/ MSS-SP-69**



Model #355N

Steel Concrete Insert Nut

APPLICATION: Hanger rod attachment to be installed inside of the Model #355 Concrete Insert.

NOTE: Installation: See Model #355

Catalog No.	Rod Size	Max. Pipe Size	Max. Recom. load (lbs)	Finish*
355N0025EG	1/4	N/A	240	EG
355N0025PL	1/"	N/A	240	PL
355N0037EG	3/8	4	610	EG
355N0037PL	3/8	4	610	PL
355N0050EG	1/2	8	1130	EG
355N0050PL	1/2	8	1130	PL
355N0062EG	5/8	8	1200	EG
355N0062PL	5/8	8	1200	PL
355N0075EG	3/4	8	1200	EG
355N0075PL	3/4	8	1200	PL
355N0087EG	7/8	**10	1200	EG
355N0087PL	7/8	**10	1200	PL

** Reduced support spacing is required. Conforms With: Federal Specification WW-H-171 (Type 19), Manufacturers Standardization Society ANSI/MSS-SP-58 (Type 1) install in accordance with ANSI/MSS-SP-69