FOSSIL & HYDRO ENGINEERING

CALCULATION COVER SHEET

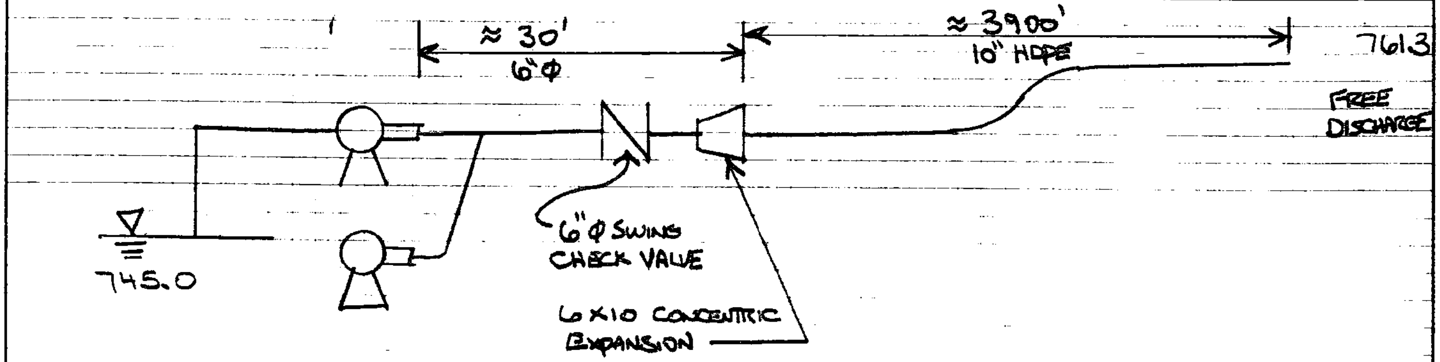
DEPT/SECTION IDENTIFIER	

FOR TVA USE ONLY		
Each time these calculations are revised, preparers must ensure that the original (R0) RIMS accession number is filled in.		
REV	(for RIM'S use)	RIMS accession number
R0		
R_		
R_		
R_		

NAME OF PLANT/UNIT	KINGSTON FOSSIL			ORGANIZATION P&DE
CALCULATION TITLE	COAL YARD PIPING - STORMWATER FORCE MAIN HYDRAULIC CALCULATIONS.			DEPARTMENT CIVIL
	SIGNATURE REQUIRED	INITIALS ONLY		
REVISION NO.	R0	R1	R2	R3
PREPARED	[signature]			
CHECKED	[signature]			
APPROVED	[signature]			
DATE	7/6/00			
REMARKS/ABSTRACT	DETERMINE PUMP OPERATING POINT FOR SINGLE & DUAL PUMP OPERATION. THESE VALUES WILL BE USED TO DETERMINE POND DRAWDOWN TIME. (SEE CALC FOR FLOOD ANALYSIS BY PARSONS).			

PARSONS CALCULATION SHEET

REV	DATE	BY	CK	TITLE KIF COAL YARD POND PIPING	PAGE NUMBER 1
0	6/26/00	TJB			
				AUTHOR T BROWN SHEET OF	



PURPOSE: EVALUATE PROPOSED PIPING SYSTEM AND PUMP SELECTION TO DETERMINE OPERATING POINT FOR SINGLE PUMP OPERATION AND DUAL-PARALLEL PUMP OPERATION.

(1) COMPUTE SYSTEM HEAD LOSSES

$$H_T = h_{STAT} + h_{fs} + \Sigma h_{ms} + h_{f\ell_{6"}} + h_{f\ell_{10"}} + \Sigma h_{\ell m} \qquad \text{(REF 1)}$$

WHERE: H_T = TOTAL SYSTEM HEAD (ft)

h_{STAT} = STATIC HEAD (ft)

h_{fs} = SUCTION HEAD LOSS (ft)

Σh_{ms} = SUM OF MINOR SUCTION LOSSES

$h_{f\ell_6}$ = HEAD LOSS IN 6" PIPE

$h_{f\ell_{10}}$ = HEAD LOSS IN 10" PIPE

$\Sigma h_{\ell m}$ = SUM OF MINOR HEAD LOSSES IN 6" & 10" PIPE

USE DARCY-WEISBACH EQUATION FOR HEAD LOSS DUE TO FRICTION (PG 3-110, REF 2)

$$h_{f\ell} = f \frac{L}{D} \frac{V^2}{2g}$$

WHERE $h_{f\ell}$ = FRICTION LOSS IN PIPE (ft)

L = PIPE LENGTH (ft)

D = PIPE DIAMETER (ft)

V = VELOCITY (ft/sec)

g = GRAVITATIONAL CONSTANT = 32.2 ft/sec^2

files\standard\a-format\forms\calcsht.doc

PARSONS

TVA-00009401

FOR 6" PIPE, USE SCH 40, STEEL, I.D = 6.065 in = 0.5054 ft (pg 7-9, REF 2)

FOR 10" HDPE, SDR 17, I.D. = 9.41 in = 0.7842 ft (Bulletin 301, REF 3)

AREA 6" = $\pi(0.5054)^2/4 = 0.2006\ ft^2$

AREA 10" = $\pi(0.7842)^2/4 = 0.4830\ ft^2$

* ASSUME SUCTION HEAD LOSS AND MINOR SUCTION LOSSES NEGLIGIBLE ∴

$H_T = h_{stat} + h_{fl_6} + h_{fl_{10}} + \Sigma h_{lm}$

FOR MINOR LOSSES, THE FOLLOWING ARE USED

$$h_{lm} = K\frac{V^2}{2g}$$ (Pg 3-110, REF 2)

WHERE K = RESISTANCE COEFFICIENT (SECTION 3, REF 2)

FOR 6" Y CONNECTION, USE STD TEE $K = 0.90$

FOR 6" CHECK VALVE, $K = 1.5$

FOR 6→10 ENLARGEMENT (GRADUAL) $K = \left(1 - \frac{d_1^2}{d_2^2}\right)^2$

$$K = \left(1 - \frac{(0.5054)^2}{(0.7842)^2}\right)^2$$

$$K = 0.34$$

FOR 10" PIPE EXIT $K = 1.0$

$$h_{lm} = (0.90 + 1.5 + 0.34)\frac{V_6^2}{2g} + 1.0\frac{V_{10}^2}{2g}$$

$$h_{stat} = h_2 - h_1 = 761.3 - 745.0 = 16.3\ ft$$

h_{fl_6} & $h_{fl_{10}}$ AND h_{lm} DEPEND ON THE RATE OF FLOW. IN ORDER TO DEVELOP A SYSTEM CURVE, SEVERAL FLOW RATES MUST BE EXAMINED TO ESTABLISH THE SYSTEM RELATIONSHIP BETWEEN FLOW RATE & HEAD LOSS.

REV	DATE	BY	CK	TITLE KIF COAL YARD POND PIPING	PAGE NUMBER 3
0	6/26/00	TJB			
				AUTHOR T BROWN SHEET OF	

FOR ALL CALCULATIONS, IT IS ASSUMED THAT THE SYSTEM WILL CONVEY FRESH WATER AS 60°F, WITH NEGLIGIBLE SOLIDS CONTENT. THE KINEMATIC VISCOSITY $= \nu = 1.2\times10^{-5}$ ft²/sec (REF 2). FOR RELATIVE ROUGHNESS (e/D) THE FOLLOWING VALUES WILL BE USED FOR THE 6" & 10" PIPE

FOR 6" STL PIPE, $e = 0.00015$, $e/D = 0.00015/0.5054 = 0.0003$

FOR 10" HDPE $e = 0.000005$ e/D: $0.000005/0.7842 = 0.000006$

FOR $Q = 1000$ GPM $= 2.228$ ft³/s $\quad R$ = REYNOLDS NUMBER $= DV/\nu$

$$V_6 = Q/A = \frac{2.228 \text{ ft}^3/\text{s}}{0.2006 \text{ ft}^2} = 11.1 \text{ ft/s} \qquad R = \frac{0.5054 \text{ ft} \times 11.1 \text{ ft/s}}{1.2\times10^{-5} \text{ ft}^2/\text{s}} = 467495$$

FROM MOODY DIAGRAM $f_6 = 0.0165$ (REF 4)

$$V_{10} = Q/A = \frac{2.228 \text{ ft}^3/\text{s}}{0.4830 \text{ ft}^2} = 4.61 \text{ ft/s} \qquad R = \frac{0.7842 \times 4.61 \text{ ft/s}}{1.2\times10^{-5} \text{ ft}^2/\text{s}} = 301264$$

$f \cong 0.0143$

$$\text{then } h_{fR_6} = f\frac{L}{D}\frac{V^2}{2g} = 0.0165 \times \frac{30 \text{ ft}}{0.5054} \times \frac{(11.1)^2}{2\times32.2} = 1.87 \text{ ft}$$

$$h_{fR_{10}} = f\frac{L}{D}\frac{V^2}{2g} = 0.0143 \times \frac{3900 \text{ ft}}{0.7842} \times \frac{(4.61)^2}{2\times32.2} = 23.47 \text{ ft}$$

$$h_{Rm_6} = (0.9 + 1.5 + 0.34)\frac{V_6^2}{2\times32.2} = 2.74\frac{(11.1)^2}{64.4} = 5.24 \text{ ft}$$

$$h_{Rm_{10}} = 1.0 \times \frac{V_{10}^2}{64.4} = \frac{(4.61)^2}{64.4} = 0.33 \text{ ft}$$

H_T @ $Q = 1000$ gpm $= 16.3$ ft $+ 1.87$ ft $+ 23.47$ ft $+ 5.24$ ft $+ 0.33$ ft $= 47.21$ ft

<u>H_T @ 1000 gpm = 47.21 FT</u>

REV	DATE	BY	CK	TITLE KIF COAL YARD POND PIPING	PAGE NUMBER 4
0	6/26/00	TJB		AUTHOR T BROWN SHEET OF	

FOR $Q = 1200\ gpm$, $= 1200\ gal/min \times 1\ ft^3/7.48\ gal \times 1\ min/60\ sec = 2.67\ ft^3/sec$

FOR 6" $V_6 = Q/A = \frac{2.67\ ft^3/sec}{0.2006\ ft^2} = 13.31\ ft/sec$ $R = \frac{0.5054\ ft \times 13.31\ ft/sec}{1.2 \times 10^{-5}\ ft^2/sec}$

$R = 560573$

FROM MOODY DIAGRAM $f \cong 0.0161$ (REF 4)

FOR 10" $V_{10} = Q/A = \frac{2.67\ ft^3/s}{0.4830\ ft^2} = 5.53\ ft/sec$ $R = \frac{0.7842\ ft \times 5.53\ ft/sec}{1.2 \times 10^{-5}\ ft^2/sec} = 361386$

FROM MOODY DIAGRAM $f \cong 0.0141$

then $h_{fl_6} = f \frac{L}{D} \frac{V^2}{2g} = 0.0161 \times \frac{30\ ft}{0.5054\ ft} \times \frac{(13.31\ ft/sec)^2}{2 \times 32.2\ ft/sec^2} = 2.63\ ft$

$h_{fl_{10}} = f \frac{L}{D} \frac{V^2}{2g} = 0.0141 \times \frac{3900\ ft}{0.7842\ ft} \times \frac{(5.53\ ft/sec)^2}{2 \times 32.2\ ft/sec^2} = 33.30\ ft$

$h_{lm_6} = \Sigma K \frac{V_6^2}{2g} = 2.74 \frac{(13.31\ ft/sec)^2}{2 \times 32.2\ ft/sec^2} = 7.54\ ft$

$h_{lm_{10}} = \Sigma K \frac{V_{10}^2}{2g} = 1.0 \frac{(5.53\ ft/sec)^2}{2 \times 32.2\ ft/sec^2} = 0.48\ ft$

H_T @ 1200gpm $= 16.3 + 2.63 + 33.3 + 7.54 + 0.48 = 60.25\ ft$

<u>HT @ 1200gpm = 60.25 ft</u>

FOR 1400 gpm $= 1400\ gal/min \times 1\ ft^3/7.48\ gal \times 1\ min/60\ sec = 3.12\ ft^3/sec$

FOR 6" $V_6 = Q/A = \frac{3.12\ ft^3/sec}{0.2006\ ft^2} = 15.55\ ft/sec$ $R = \frac{0.5054\ ft \times 15.55\ ft/sec}{1.2 \times 10^{-5}\ ft^2/sec}$

$R = 654914$

FROM MOODY'S DIAGRAM $f \cong 0.0160$

REV	DATE	BY	CK	TITLE KIF COAL YARD POND PIPING	PAGE NUMBER 5
0	6/26/00	TLB		AUTHOR T BROWN SHEET OF	

FOR 10" $V_{10} = Q/A = \frac{3.12\ ft^3/sec}{0.4830\ ft^2} = 6.46\ ft/sec$

$R = \frac{0.7842\ ft \times 6.46\ ft/sec}{1.2\times10^{-5}\ ft^2/sec} = 422161$

FROM MOODY'S DIAGRAM $f \cong 0.014$

THEN $hfl_6 = f \frac{L}{D} \frac{V^2}{2g} = 0.0160 \times \frac{30\ ft}{0.5054\ ft} \times \frac{(15.55\ ft/sec)^2}{2\times32.2\ ft/sec^2} = 3.57\ ft$

$hfl_{10} = f \frac{L}{D} \frac{V^2}{2g} = 0.014 \times \frac{3900\ ft}{0.7842\ ft} \times \frac{(6.46\ ft/sec)^2}{2\times32.2\ ft^2/sec} = 45.12\ ft$

$hl_{m6} = \Sigma K \frac{V^2}{2g} = 2.74 \frac{(15.55\ ft/sec)^2}{2\times32.2\ ft/sec^2} = 10.29\ ft$

$hl_{m10} = \Sigma K \frac{V^2}{2g} = 1.0 \frac{(6.46\ ft/sec)^2}{2\times32.2\ ft/sec^2} = 0.65\ ft$

H_T @ 1400 gpm = 16.3 + 3.57 + 45.12 + 10.29 + 0.65 ft = 75.93 ft

<u>H_T @ 1400 gpm = 75.93 ft</u>

FOR Q = 1600 gpm = 1600 gal/min × 1 ft³/7.48 gal × 1 min/60 sec = 3.57 ft³/sec

FOR 6" $V_6 = Q/A = \frac{3.57\ ft^3/sec}{0.2006\ ft^2} = 17.8\ ft/sec$ $R = \frac{0.5054\ ft \times 17.8\ ft/sec}{1.2\times10^{-5}\ ft^2/sec} = 749677$

FROM MOODY DIAGRAM $f \cong 0.0159$

FOR 10" $V_{10} = Q/A = \frac{3.57\ ft^3/sec}{0.4830\ ft^2} = 7.39\ ft/sec$ $R = \frac{0.7842\ ft \times 7.39\ ft/sec}{1.2\times10^{-5}\ ft^2/sec} = 482937$

FROM MOODY DIAGRAM $f \cong 0.0139$

THEN $hfl_6 = f \frac{L}{D} \frac{V^2}{2g} = 0.0159 \times \frac{30\ ft}{0.5054\ ft} \times \frac{(17.8\ ft/sec)^2}{2\times32.2\ ft/sec^2} = 4.64\ ft$

$hfl_{10} = f \frac{L}{D} \frac{V^2}{2g} = 0.0139 \times \frac{3900\ ft}{0.7842\ ft} \times \frac{(7.39\ ft/sec)^2}{2\times32.2\ ft/sec^2} = 58.62\ ft$

$$h_{lm_6} = \Sigma K \frac{V^2}{2g} = 2.74 \frac{(17.8\ ft/sec)^2}{2 \times 32.2\ ft/sec^2} = 13.48\ ft$$

$$h_{lm_{10}} = \Sigma K \frac{V^2}{2g} = 1.0 \frac{(7.39\ ft/sec)^2}{2 \times 32.2\ ft/sec^2} = 0.85\ ft$$

H_T @ 1600 gpm = 16.3 + 4.64 + 58.62 + 13.48 + 0.85 = 93.89 ft

<u>H_T @ 1600 gpm = 93.89 ft</u>

FOR Q = 1800 gpm $= 1800\ gal/min \times \frac{1\ ft^3}{7.48\ gal} \times \frac{1\ min}{60\ sec} = 4.01\ ft^3/sec$

FOR 6" $V_6 = Q/A = \frac{4.01\ ft^3/sec}{0.2006\ ft^2} = 19.99\ ft/sec$ $\quad R = \frac{0.5054\ ft \times 19.99\ ft/sec}{1.2 \times 10^{-5}\ ft^2/sec} = 841912$

FROM MOODY DIAGRAM $f \cong 0.0157$

FOR 10" $V_{10} = Q/A = \frac{4.01\ ft^3/sec}{0.4830\ ft^2} = 8.3\ ft/sec$ $\quad R = \frac{0.7842\ ft \times 8.30\ ft/sec}{1.2 \times 10^{-5}\ ft^2/sec} = 542405$

FROM MOODY DIAGRAM $f \cong 0.0136$

$$h_{fl_6} = f \frac{L}{D} \frac{V^2}{2g} = 0.0157 \times \frac{30\ ft}{0.5054\ ft} \times \frac{(19.99\ ft/sec)^2}{2 \times 32.2\ ft/sec^2} = 5.78\ ft$$

$$h_{fl_{10}} = f \frac{L}{D} \frac{V^2}{2g} = 0.0136 \times \frac{3900\ ft}{0.7842\ ft} \times \frac{(8.3\ ft/sec)^2}{2 \times 32.2\ ft/sec^2} = 72.35\ ft$$

$$h_{lm_6} = \Sigma K \frac{V^2}{2g} = 2.74 \times \frac{(19.99\ ft/sec)^2}{2 \times 32.2\ ft/sec^2} = 17.00\ ft$$

$$h_{lm_{10}} = \Sigma K \frac{V^2}{2g} = 1.0 \times \frac{(8.3\ ft/sec)^2}{2 \times 32.2\ ft/sec^2} = 1.07\ ft$$

H_T @ 1800 gpm = 16.3 + 5.78 + 72.35 + 17.0 + 1.07 = 112.5 ft

<u>H_T @ 1800 gpm = 112.5 ft</u>

REV	DATE	BY	CK	TITLE KIF COAL YARD POND PIPING	PAGE NUMBER 7
0	6/26/00	DB			
				AUTHOR T BROWN SHEET OF	

FOR Q = 2000 gpm = $2000\ gal/min \times \frac{1\ ft^3}{7.48\ gal} \times \frac{1\ min}{60\ sec} = 4.46\ ft^3/sec$

FOR 6" $V_6 = Q/A = \frac{4.46\ ft^3/sec}{0.2006\ ft^2} = 22.23\ ft/sec$

$R = \frac{0.5054\ ft \times 22.23\ ft/sec}{1.2\times10^{-5}\ ft^2/sec} = 936254$

FROM MOODY DIAGRAM, $f \cong 0.0154$

FOR 10" $V_{10} = Q/A = 4.46\ ft^3/sec / 0.4830\ ft^2 = 9.23\ ft/sec$

$R = \frac{0.7842\ ft \times 9.23\ ft/sec}{1.2\times10^{-5}\ ft^2/sec} = 603181$

FROM MOODY DIAGRAM $f \cong 0.0130$

$h_{fl_6} = f \frac{L}{D} \frac{V^2}{2g} = 0.0154 \times \frac{30\ ft}{0.5054} \times \frac{(22.23\ ft/sec)^2}{2\times32.2\ ft/sec^2} = 7.02\ ft$

$h_{fl_{10}} = f \frac{L}{D} \frac{V^2}{2g} = 0.0130 \times \frac{3900\ ft}{0.7842\ ft} \times \frac{(9.23\ ft/sec)^2}{2\times32.2\ ft/sec^2} = 85.53\ ft$

$h_{lm_6} = \Sigma K \frac{V^2}{2g} = 2.74 \times \frac{(22.23\ ft/sec)^2}{2\times32.2\ ft/sec^2} = 21.03\ ft$

$h_{lm_{10}} = \Sigma K \frac{V^2}{2g} = 1.0 \times \frac{(9.23\ ft/sec)^2}{2\times32.2\ ft/sec^2} = 1.32\ ft$

H_T @ 2000 gpm = 16.3 + 7.02 + 85.53 + 21.03 + 1.32 = 131.2 ft

<u>H_T @ 2000 gpm = 131.2 ft</u>

REV	DATE	BY	CK	TITLE KIF COAL YARD POND PIPING	PAGE NUMBER 8
0	6/26/00	TB			
				AUTHOR T BROWN SHEET OF	

WITH SYSTEM HEAD LOSSES KNOWN OVER A RANGE OF FLOW CONDITIONS, PLOT SYSTEM HEAD CURVE ON PUMP CURVE TO DETERMINE OPERATING POINT FOR PUMP. SINCE 2 PUMPS MAY BE USED SIMULTANEOUSLY IN PARALLEL, ALSO PLOT SYSTEM HEAD CURVE ON 2-PUMP CURVE TO DETERMINE OPERATING POINT USING 2-PUMPS IN PARALLEL OPERATION.

TO CONSTRUCT PUMP CURVE FOR PARALLEL OPERATION, ADD PUMP CAPACITIES FOR GIVEN HEAD, NEGLECTING SUCTION LOSSES.

SUMMARY OF RESULTS:

SINGLE PUMP OPERATING PT = 1410 gpm @ 77 ft TDH

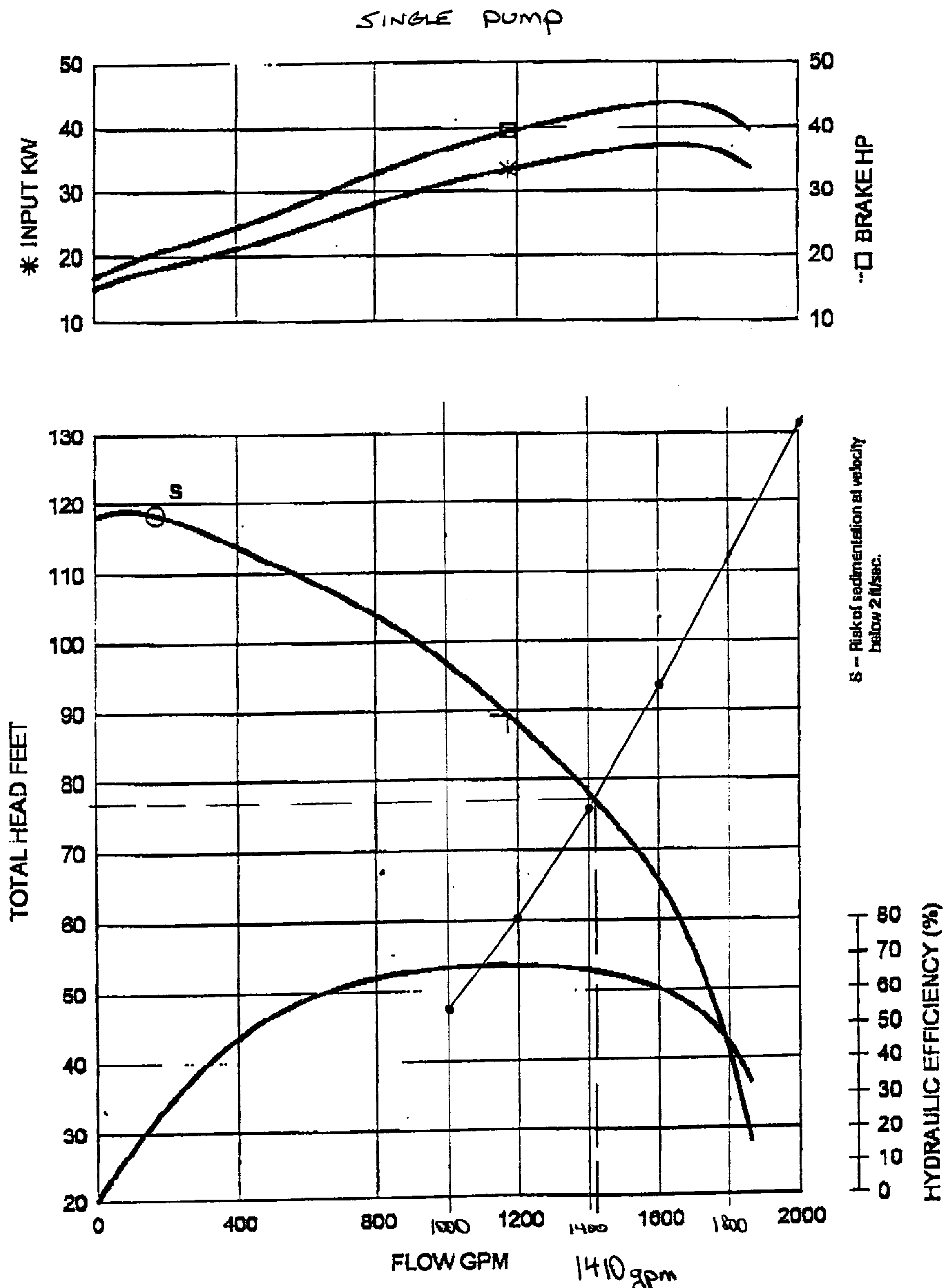
2 PUMPS IN PARALLEL, OPERATING PT = 1700 gpm @ 102.7 ft TDH

ADDING 2ND PUMP INCREASES FLOW BY $(1700-1410)/1410 = 20.6\%$

Pg 9

REF 5

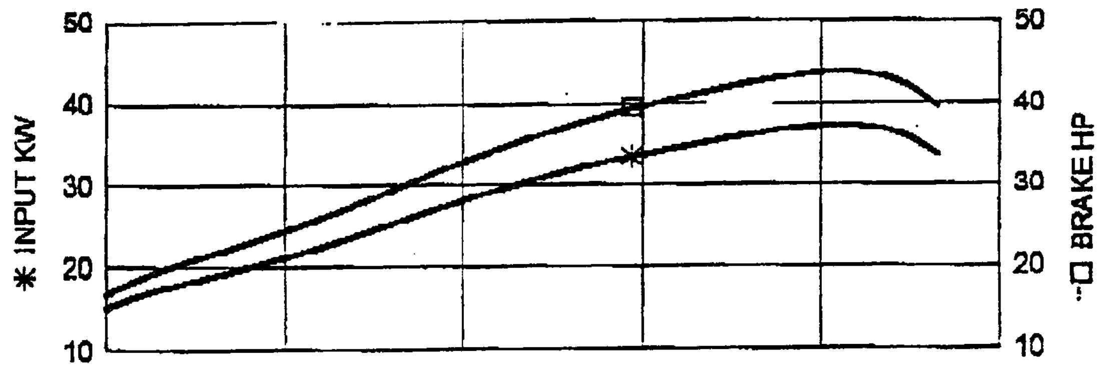
CONFIG		C-3201	SECTION	PAGE
HP/HS		462 Impeller	3	9
PHASE	VANES		SUPERSEDES	ISSUED
3	3		2/88	6/94



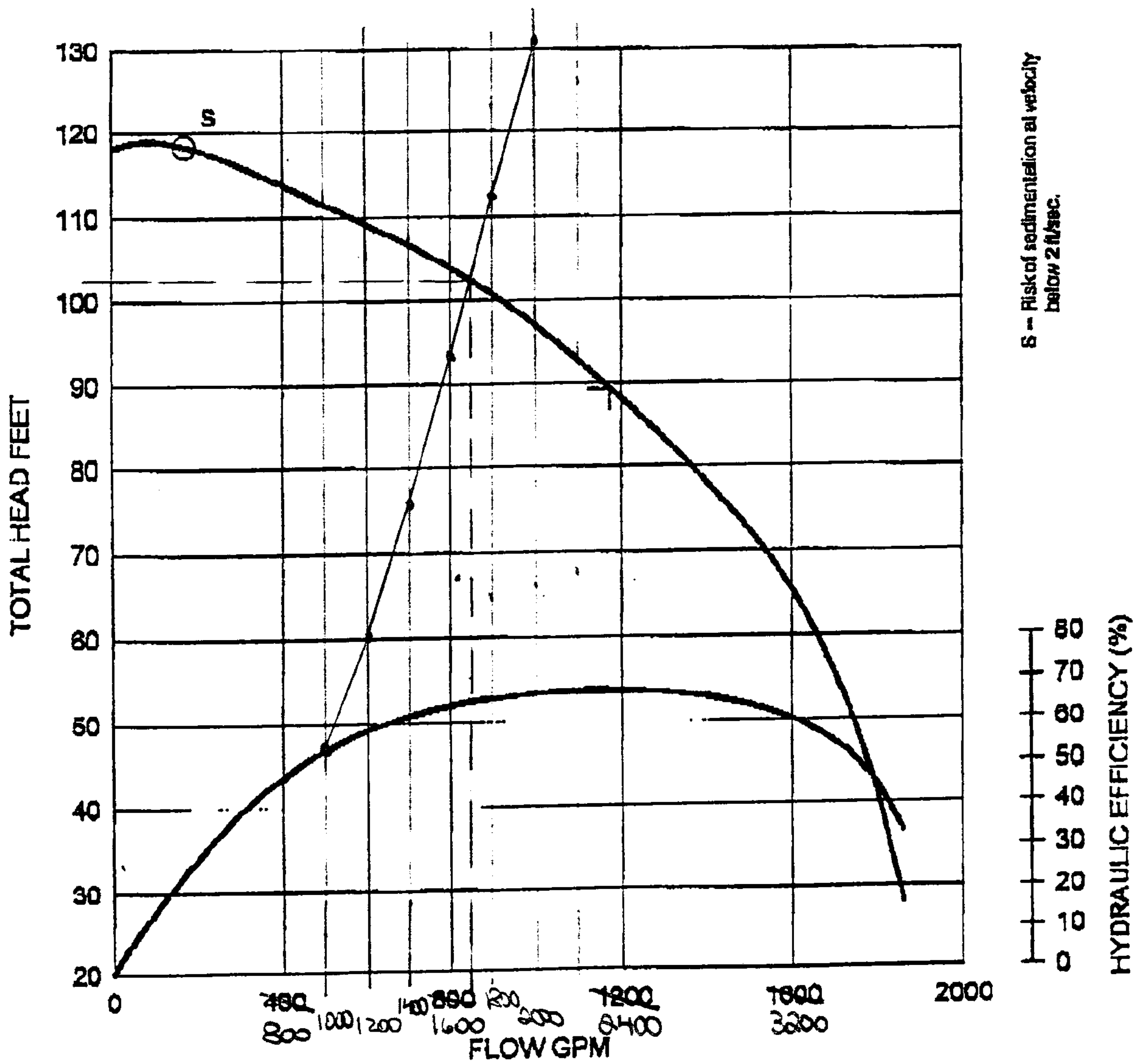
REF 5

CONFIG		C-3201 462 Impeller	SECTION	PAGE
HP/HS			3	9
PHASE	VANES		SUPERSEDES	ISSUED
3	3		2/88	6/94

2 PUMPS IN PARALLEL



* SUCTION LOSSES NOT INCLUDED



2 Pumps @ ≈ 1700 gpm

REV	DATE	BY	CK	TITLE KIF COAL YARD POND PIPING	PAGE NUMBER 11
0	6/26/00	TJB			
				AUTHOR T BROWN SHEET OF	

REFERENCES:

1) "WASTEWATER ENGINEERING: COLLECTION AND PUMPING OF WASTEWATER", METCALF & EDDY, INC., McGRAW-HILL 1981.

2) "CAMERON HYDRAULIC DATA", INGERSOLL-RAND COMPANY, 17th ed., 1988

3) "BULLETIN No. 301" PLEXCO PIPE, REV. 3-93.

4) DAUGHERTY, R.L., FRANZINI, J.B., FINNEMORE, E.J., "FLUID MECHANICS WITH ENGINEERING APPLICATIONS", 8th ed, McGRAW-HILL, 1985.

5) FAX TRANSMISSION FROM JOHN BOUCHARD & SONS CO., PUMP CURVE FOR FLYGHT C-3201 PUMP. MAY 5, 2000

PE 3408 Industrial Piping System
Pipe Data and Pressure Ratings

Bulletin No. 301

Chevron Plexco

(Pipe weights are calculated in accordance with PPI TR-7)
Average inside diameter calculated on minimum wall plus 6%.

Pressure Ratings are for water at 73°F. For other fluids and service temperatures ratings may differ, refer to Application Note No. 6 Chemical and Environmental Considerations.

[illegible]		100 psi DR 17.0			80 psi DR 21.0			65 psi DR 26.0			50 psi DR 32.5			40 psi DR 41.0			
IPS* Pipe Size	Nominal OD (in.)	Minimum Wall (in.)	Average ID (in.)	Weight LB/FT	Minimum Wall (in.)	Average ID (in.)	Weight LB/FT	Minimum Wall (in.)	Average ID (in.)	Weight LB/FT	Minimum Wall (in.)	Average ID (in.)	Weight LB/FT	Minimum Wall (in.)	Average ID (in.)	Weight LB/FT	IPS* Pipe Size
1¼"																	1¼"
1½"																	1½"
2"	2.375	0.140	2.078	0.43													2"
3"	3.500	0.206	3.063	0.93													3"
4"	4.500	0.265	3.938	1.54	0.214	4.046	1.26										4"
5⅜"	5.375	0.316	4.705	2.20	0.256	4.832	1.80	0.207	4.936	1.47							5⅜"
5"	5.563	0.327	4.870	2.35	0.265	5.001	1.93	0.214	5.109	1.58							5"
6"	6.625	0.390	5.798	3.34	0.315	5.957	2.73	0.255	6.084	2.23	0.204	6.193	1.80				6"
7⅛"	7.125	0.419	6.237	3.86	0.339	6.406	3.16	0.274	6.544	2.58	0.219	6.661	2.08				7⅛"
8"	8.625	0.507	7.550	5.65	0.411	7.754	4.64	0.332	7.921	3.79	0.265	8.063	3.05				8"
10"	10.750	0.632	9.410	8.78	0.512	9.665	7.21	0.413	9.874	5.87	0.331	10.048	4.75				10"
12"	12.750	0.750	11.160	12.36	0.607	11.463	10.13	0.490	11.711	8.26	0.392	11.919	6.67				12"
13⅜"	13.375	0.787	11.707	13.60	0.637	12.025	11.15	0.514	12.285	9.09	0.412	12.502	7.35				13⅜"
14"	14.000	0.824	12.253	14.91	0.667	12.586	12.22	0.538	12.859	9.96	0.431	13.086	8.05				14"
16"	16.000	0.941	14.005	19.46	0.762	14.385	15.97	0.615	14.696	13.02	0.492	14.957	10.51				16"
18"	18.000	1.059	15.755	24.65	0.857	16.183	20.19	0.692	16.533	16.48	0.554	16.826	13.29				18"
20"	20.000	1.176	17.507	30.42	0.952	17.982	24.92	0.769	18.370	20.34	0.615	18.696	16.41				20"
22"	22.000	1.294	19.257	36.81	1.048	19.778	30.19	0.846	20.206	24.62	0.677	20.565	19.87				22"
24"	24.000	1.412	21.007	43.82	1.143	21.577	35.92	0.923	22.043	29.29	0.738	22.435	23.62				24"
†26"	26.000	1.529	22.759	51.40	1.238	23.375	42.13	1.000	23.880	34.39	0.800	24.304	27.74				†26"
†28"	28.000	1.647	24.508	59.62	1.333	25.174	48.86	1.077	25.717	39.89	0.862	26.173	32.20				†28"
†30"	30.000	1.765	26.258	68.45	1.429	26.971	56.13	1.154	27.554	45.78	0.923	28.043	36.92	0.732	28.448	29.50	†30"
†32"	32.000	1.882	28.010	77.86	1.524	28.769	63.83	1.231	29.390	52.10	0.985	29.912	42.04	0.780	30.346	33.53	†32"
†34"	34.000	2.000	29.760	87.91	1.619	30.568	72.06	1.308	31.227	58.79	1.046	31.782	47.44	0.829	32.243	37.87	†34"
†36"	36.000	2.118	31.510	98.56	1.714	32.366	80.79	1.385	33.064	65.93	1.108	33.651	53.18	0.878	34.139	42.47	†36"
†42"	42.000				2.000	37.760	109.97	1.615	38.576	89.71	1.292	39.261	72.40	1.024	39.829	57.74	†42"
†48"	48.000				2.286	43.154	143.64	1.846	44.086	117.20	1.477	44.869	94.58	1.171	45.517	75.48	†48"
†54"	54.000				2.571	48.549	181.74	2.077	49.597	148.35	1.662	50.477	119.72	1.317	51.208	95.52	†54"

* Industrial PE (polyethylene) pipe sizes are identified by IPS (iron pipe size) diameters which designate the nominal diameter for 12" IPS AND SMALLER PIPE, AND O.D. (outside diameter) for 14" IPS and larger pipe.

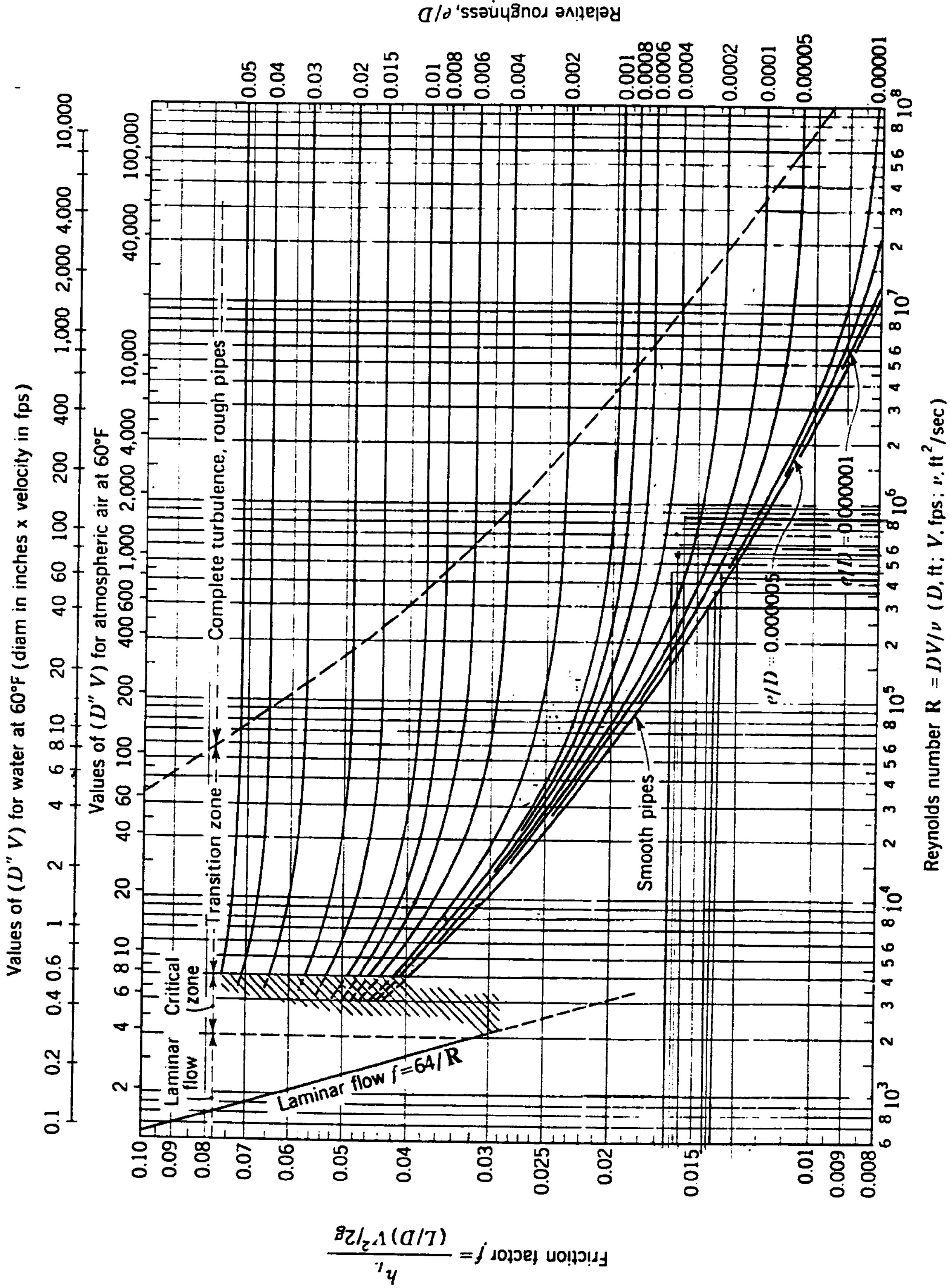
PLEXCO can produce to specialized pipe dimensions. Check with your PLEXCO sales office for availability of dimensions not listed.

† SUBJECT TO MINIMUM ORDER QUANTITIES, AND AVAILABILITY OF TOOLING.

Rev. 3/93

(REF. 3) PG 12

REF. 4


Relative roughness, e/D
Values of (D" V) for water at 60°F (diam in inches x velocity in fps)
Values of (D" V) for atmospheric air at 60°F
Complete turbulence, rough pipes
Transition zone
Critical zone
Laminar flow
Laminar flow f=64/R
Smooth pipes
e/D = 0.000005
e/D = 0.000001
Friction factor f = h_L / ((L/D) V²/2g)
Reynolds number R = DV/ν (D, ft; V, fps; ν, ft²/sec)
0.05
0.04
0.03
0.02
0.015
0.01
0.008
0.006
0.004
0.002
0.001
0.0008
0.0006
0.0004
0.0002
0.0001
0.00005
0.00001
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.025
0.02
0.015
0.01
0.009
0.008