

Vapor Collection System Pressure Drop Calculations

for

Hull 455

for

Raymond and Associates, LLC.

rev. 1

12 April, 2012

Prepared by: The Shearer Group, Inc
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Vessel Information:

Builder:	Raymond and Associates, LLC
Hull #:	455
O.N.	1237980
Owner:	Harley Marine Gulf, LLC
Name:	"Paige Katherine"
Length:	297.5 ft
Breadth:	54.0 ft
Depth:	12.0 ft
Classification:	n/a
Service:	Rivers, Lakes, Bays, Sounds
Cargo:	Subchapter D

Vapor System Information:**Pipe:**

Header:	8" schedule 40
Manifold:	8" schedule 40

Notes:

All tanks are to be connected to the main header and PV valve during cargo loading or discharge. Port and Starboard tanks to be loaded simultaneously.

High-Velocity P-V Valve:**ERL SUPERAC MODEL II**

Pressure Setting:	1.5 psi
Vacuum Setting:	0.5 psi
Flow Capacity:	16436 BBL/hr @ 2.23 psi loading (pressure)
	10673 BBL/hr @ 0.49 psi discharge (vacuum)

Maximum Liquid Loading Rate:**5000 BBL/hr****Maximum Discharge Rate:****5000 BBL/hr****Maximum Vapor-Air Mixture Density:****0.347 lb/ft³** for Subchapter D

Summary of Calculations:

1. Cargo Authority

The vapor collection system on this barge is designed to carry the cargoes listed in the accompanying List of Allowable Cargoes.

These calculations estimate the flow characteristics for a number of cargoes in terms of a suitable flowrate for the vapor collection and overpressure protection system only. These calculations do not assess additional carriage considerations which may exist for the listed cargoes (e.g. IBC & USCG requirements) based on other characteristics of the cargoes - toxicity, pollution potential, pressure and temperature restrictions, and other hazardous characteristics whic may affect vessel outfit, equipment, and operations.

The VCS cargoes shall be listed on the barge's Certificate of Inspection, pending carriage authority from USCG.

2. Vapor-Air Mixture Density and Vapor Growth Rate

The maximum vapor-air mixture density, estimated in accordance with USCG "Industry Guidelines for Determining the Maximum Liquid Transfer Rate for A Tank Vessel Transferring a Flammable or Combustible Cargo Using a Vapor Control System (USCG Guidelines) is:

0.347 lb/ft³ for a 50/50 mixture of air and Subchapter O/D products

The vapor growth rate is calculated in accordance with the USCG Guidelines, as $R = 1 + 0.25 (VP/12.5)$; however, a minimum of 1.25 is used in all loading cases, in accordance with ABS SBR 5-2-3/7.5.2(d) and 46 CFR 39.30-1(b)(2) as stipulated for crude oil, benzene, and gasoline blends.

See the accompanying List of Allowable Cargoes or specific data on vapor-air mixture density and vapor growth rates for various cargoes.

3. Maximum Liquid Transfer Rate as Imposed by the Capacity of the Cargo Tank Venting Systems (46 CFR 39.20-11 & 39.30-1(d))

Design Cargo S.G.: 1.05
Deck Design Pressure/Vacuum: 3.00 psig

LOADING:

Tank #1 presents the longest equivalent pipe run to the high-velocity P-V valve. Using friction factors appropriate to the applicable pipe sizes, the maximum pressure drop through the vapor control piping at the maximum liquid transfer rate of

5000 BBL/hr is:

The air-equivalent flowrate through the P-V valve is: 0.343 psi for a 50/50 mix of air and Subchapter D products
The pressure drop across the P-V valve at this flowrate is: 16436 BBL/hr
The total pressure drop: 2.23 psi
2.57 psi ≤ the design pressure of 3.00 psi

DISCHARGE:

The maximum pressure drop through the vapor piping at the maximum discharge rate of 5000 BBL/hr is:

The air-equivalent flowrate through the P-V valve is: 0.147 psi for a 50/50 mix of air and Subchapter D products
The pressure drop across the P-V valve at this flowrate is: 10673 BBL/hr (a density adjustment is conservatively used to provide for fouling)
The total pressure drop: 0.49 psi
0.64 psi ≤ the design pressure of 3.00 psi

4. Maximum Liquid Transfer Rate as Imposed by the Spill Valves (46 CFR 39.20-9(c)(3))

No spill valves are installed on the vessel.

5. Maximum Liquid Transfer Rate as Imposed by the Set Point of the High-Level Alarm (46 CFR 39.20-7(c)(1) and -9(b)(2))

High Level Alarm Set Point:

Cargo Height: 12.83 ft (Approx) Tank #1 at 95% load, per 46 CFR 39.30-1(e)(1) and ABS SBR 5-2-3/7.19.2
High-Level Sensor Height: 12.83 ft (corresponds to 95% load)
Cargo Volume above Sensor: 836 BBL
Maximum Tank Loading Rate: 2500 BBL/hr per tank
Time to Overfill: 1203.8 sec

6. Maximum Liquid Transfer Rate as Imposed by the Pressure Drop to the Facility Vapor Connection (46 CFR 39.30-1(d)(3))

The pressure drop through the most restrictive path (Tank #1) to the facility vapor connection shall not exceed 80% of the P-V valve setting. Pressure Drop calculations for each cargo at 25%, 50%, 75% and 100% of maximum loading rate are attached. From this data, a plot of allowable pressure at the facility vapor connection versus liquid loading rate is generated.

Curves are provided for representative cargoes, including:

the heaviest: Pentane (iso-) with a Vapor-Air mixture density of 0.347 lb/ft³
and the lightest: with a mixture density of 0.076 lb/ft³
as well as intermediate cargoes.

The maximum allowable backpressure at the FVC is: 0.524 PSIG for the highest density cargo at the maximum loading rate.

The operator shall monitor pressure at the facility vapor connection and adjust the loading rate when necessary, for the particular cargo being loaded, in order to maintain cargo tank pressure within acceptable limits.

Pipe Length and Valve & Fitting Equivalent Lengths:

Pipe sizes, nominal (in):	8
Pipe ID (in):	7.981
Pipe ID (ft):	0.665
Pipe Flow Area (in ²):	50.03
Reynold's Number:	Varies (see attached sheets)
f, friction factor, pipe:	Varies (see attached sheets)
f _v , friction factor (fittings):	0.014

Friction Factors for Clean Commercial Steel Pipe, Crane 410 Table A-25, function of Reynold's Number, pipe condition, and pipe diameter (see attached sheets)

Pipe Friction Data for Clean Commercial Steel Pipe (Turbulent Flow), Crane 410, Table A-25

CONDITION #1 - Relief through P/V Valve during loading or discharge

From #1 Cargo Tank to P/V Valve (per 46 CFR 39.30 - 1(d)(1)&(2) and ABS SBR 5-2-3/7.5.2(a)&(b))

PIPE

Description	ID (in)	Length (ft)
Straight Pipe	7.981	125.38

L_{8"} PIPE:	125.38	ft
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VALVES & FITTINGS

Description	ID (in)	Qty	L _{eq} /D = K/f _t ¹	K ²	L _{eq} ³
Entrance	7.981	1	56	0.78	37.055
T-Branch	7.981	2	60	0.84	39.905
T-Run	7.981	2	20	0.28	13.302
90° Elbow	7.981	1	30	0.42	19.953
Butterfly Valve	7.981	1	45	0.63	29.929
8x6 reducer (sudden)	7.981	1	49	0.69	32.844

Total K	Total L _{eq}
0.78	37.05
1.68	79.81
0.56	26.60
0.42	19.95
0.63	29.93
0.69	32.84

L_{EQ8"} VALVES & FITTINGS:	226.19	ft
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CONDITION #2 - Vapor Collection via Shore Connection

From #1 Cargo Tank to Shore Connection (per 46 CFR 39.30 - 1(d)(3) and ABS SBR 5-2-3/7.5.2(c))

PIPE

Description	ID (in)	Length (ft)
Straight Pipe	7.981	221.944

L_{8"} PIPE:	221.94	ft
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Vapor Recovery Hose ⁴	6.065	50.000
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L_{6"} HOSE:	50.000	ft
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VALVES & FITTINGS

Description	ID (in)	Qty	L _{eq} /D = K/f _t ¹	K ²	L _{eq} ³
Entrance	7.981	1	56	0.78	37.055
T-Branch	7.981	2	60	0.84	39.905
T-Run	7.981	4	20	0.28	13.302
90° Elbow	7.981	1	30	0.42	19.953
45° Elbow	7.981	4	16	0.22	10.641
Butterfly Valve	7.981	1	45	0.63	29.929
8x6 reducer (60°)	7.981	1	35	0.49	23.224

Total K	Total L _{eq}
0.78	37.05
1.68	79.81
1.12	53.21
0.42	19.95
0.90	42.57
0.63	29.93
0.49	23.22

L_{EQ8"} VALVES & FITTINGS:	285.74	ft
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1) L_{eq}/D and K determined from "K" Factor table, sheets 1-4, Crane 410 pp A-26 thru A-29 for valves & fittings based on turbulent flow friction factor.

2) K calculated from tabular L_{eq}/D and ft values where applicable:

$$K = f_t (L_{eq}/D)$$

or directly from tabular data, where given.

3) Valve or fitting equivalent length based on pipe ID:

$$L_{eq} = (L_{eq}/D) \times D$$

or L_{eq} = KD/f_t when taken directly from tabular data.

4) Hose friction factor assumed similar to Sch 40 clean commercial steel pipe, based on available manufacturer information.

499	TOL	Toluene	0.87	1.50	3.14	0.091	1.25	1.09	6250	6841	5000	5473
502	TCP	Tricresyl Phosphate (less than 1% of the ortho isomer)	1.16	0.01	12.69	0.077	1.25	1.00	6250	6273	5000	5018
503	TRD	Tridecane	0.76	0.02	6.40	0.077	1.25	1.00	6250	6271	5000	5017
505	TDN	Tridecanol , See Alcohols (C13 and above)	0.85	0.01	6.91	0.076	1.25	1.00	6250	6261	5000	5009
506	TDC	l-Tridecene	0.77	0.01	6.29	0.076	1.25	1.00	6250	6260	5000	5008
508	TEB	Triethylbenzene	0.86	0.02	5.60	0.077	1.25	1.00	6250	6268	5000	5014
509	TEG	Triethylene Glycol	1.12	0.01	5.17	0.076	1.25	1.00	6250	6258	5000	5007
519	TRE	Trimethylbenzenes (all isomers)	0.89	0.14	4.20	0.078	1.25	1.01	6250	6336	5000	5069
520	TMB	Trimethyl Benzene (1,2,5-)	0.89	0.14	4.14	0.078	1.25	1.01	6250	6334	5000	5067
521	TMD	Trimethyl Benzene (1,2,3-)	0.89	0.14	4.14	0.078	1.25	1.01	6250	6334	5000	5067
522	TME	Trimethyl Benzene (1,2,4-) (Pseudocumene)	0.89	0.14	4.14	0.078	1.25	1.01	6250	6334	5000	5067
529	TRP	Trixylenyl Phosphate	1.16	0.00	14.20	0.076	1.25	1.00	6250	6250	5000	5000
533	UDC	Undecene (1-)	0.75	0.05	5.32	0.077	1.25	1.01	6250	6292	5000	5033
534	UND	Undecyl Alcohol	0.84	0.01	5.94	0.076	1.25	1.00	6250	6260	5000	5008
546	XLX	Xylenes (Ortho-, meta-, para-)	0.89	0.51	3.66	0.083	1.25	1.04	6250	6507	5000	5205
547	XLN	Xylene (M-)	0.87	0.51	3.66	0.083	1.25	1.04	6250	6507	5000	5205
548	XLO	Xylene (O-)	0.89	0.40	3.66	0.081	1.25	1.03	6250	6452	5000	5162
549	XLP	Xylene (P-)	0.86	0.51	3.66	0.083	1.25	1.04	6250	6507	5000	5205
550	XYL	Xylenol	1.01	0.10	3.66	0.077	1.25	1.01	6250	6301	5000	5041
551		Zinc Dialkyldithiophosphate										

Note: All product data extracted from Chemical Hazard Response Information System (CHRIS), Chemical Data Guide for Bulk Shipment by Water, or best available petroleum vendor data, where omitted.

- Based on a dry air density of: **0.076 lb/ft³** and 50%-50% mixture of vapor and air at P-V set pressure of **16.20 PSIA** and T = **115 F**
 $\rho_{v-a} = (SG_v V_v + V_a) [0.0047(P_v/V)]$ where $V_v = P_v/P_t$ and $V_a = (P_t - P_v)/P_t$, and $P_t = P_{atm}$ (see USCG VCS Guidelines Rev 10-01, 7/15/01)
 (note: vapor-air density and vapor growth rate calculations for Pentane (vapor pressure > 14.7 PSIA) are per USCG Guidelines)
- Vapor Growth Rate, $R = 1 + 0.25 (VP/12.5)$ but not less than 1.25, in accordance with ABS SBR 5-2-3/7.5.2(d) and 46 CFR 39.30-1(b)(2) for loading. No growth rate or density correction is required for discharge (vacuum) relieving capacity per USCG guidance. Density correction has been maintained for conservatism and as a provision for fouling.
- Density Correction Factor, $F = (\rho_{v-a}/\rho_a)^{1/2}$ per ABS SBR 5-2-3/7.5.2(d)

Pressure Drop through VCS - From #1 Cargo Tank to P/V Valve (per 46 CFR 39.30-1(d)(1)&(2) and ABS SBR 5-2-3/7.5.2(a)&(b))

Pipe sizes, nominal: 8 in
Pipe ID: 7.981 in
Pipe Flow Area: 50.03 in²
Vapor Dynamic Viscosity: 0.019 centipoise (estimated, based on air @ 115F, Crane 410, Table A-5)

PIPE LENGTH

Length (ft): 125.375 ft (Condition 1)
f, friction factor (pipe): Varies with Reynold's Number (see table below)

VALVE & FITTING EQUIVALENT LENGTH

Equivalent Length (ft): 226.19 ft (Condition 1)
f_v, friction factor, turbulent flow (fittings): 0.014 constant, for each pipe size

Loading (Pressure) Condition:

Cargo	Vapor-Air Mix. Density (lb/ft ³)	Vapor Flow Rate BBL/hr ft ³ /s		Reynold's Number		Friction Factor		Vapor Velocity		Head Loss				Component ΔP				ΔP	
				8" Pipe		8" Pipe		8" Pipe				8" Pipe	8" Fittings			8" Pipe	8" Fittings	TOTAL	
								ft/s				ft	ft			psi	psi	psi	
1	0.123	6250	9.75			179807		0.0175				28.1	40.44	58.21		0.0346	0.0498	0.0844	
2	0.085	6250	9.75			124102		0.0185				28.1	42.62	58.21		0.0252	0.0344	0.0595	
19	0.082	6250	9.75			119053		0.0186				28.1	42.89	58.21		0.0243	0.0330	0.0572	
20	0.079	6250	9.75			115371		0.0187				28.1	43.10	58.21		0.0236	0.0319	0.0556	
21	0.079	6250	9.75			115371		0.0187				28.1	43.10	58.21		0.0236	0.0319	0.0556	
23	0.079	6250	9.75			115371		0.0187				28.1	43.10	58.21		0.0236	0.0319	0.0556	
24	0.079	6250	9.75			115371		0.0187				28.1	43.10	58.21		0.0236	0.0319	0.0556	
26	0.079	6250	9.75			115371		0.0187				28.1	43.10	58.21		0.0236	0.0319	0.0556	
34	0.077	6250	9.75			113045		0.0188				28.1	43.23	58.21		0.0232	0.0313	0.0545	
40	0.085	6250	9.75			123525		0.0185				28.1	42.65	58.21		0.0251	0.0342	0.0592	
42	0.097	6250	9.75			142057		0.0181				28.1	41.78	58.21		0.0282	0.0393	0.0675	
44	0.083	6250	9.75			121054		0.0186				28.1	42.78	58.21		0.0246	0.0335	0.0581	
46	0.086	6250	9.75			125447		0.0185				28.1	42.55	58.21		0.0254	0.0347	0.0601	
47	0.097	6250	9.75			141920		0.0181				28.1	41.78	58.21		0.0282	0.0393	0.0675	
48	0.077	6250	9.75			111843		0.0188				28.1	43.30	58.21		0.0230	0.0310	0.0540	
58	0.078	6250	9.75			113992		0.0187				28.1	43.18	58.21		0.0234	0.0316	0.0550	
64	0.077	6250	9.75			112166		0.0188				28.1	43.28	58.21		0.0231	0.0310	0.0541	
70	0.085	6250	9.75			124349		0.0185				28.1	42.60	58.21		0.0252	0.0344	0.0596	
72	0.116	6250	9.75			169855		0.0177				28.1	40.75	58.21		0.0329	0.0470	0.0799	
73	0.078	6250	9.75			113693		0.0187				28.1	43.19	58.21		0.0234	0.0315	0.0548	
74	0.080	6250	9.75			117262		0.0187				28.1	42.99	58.21		0.0240	0.0325	0.0564	
76	0.078	6250	9.75			113904		0.0187				28.1	43.18	58.21		0.0234	0.0315	0.0549	
77	0.078	6250	9.75			113752		0.0187				28.1	43.19	58.21		0.0234	0.0315	0.0549	
78	0.076	6250	9.75			111445		0.0188				28.1	43.33	58.21		0.0230	0.0308	0.0538	
79	0.076	6250	9.75			111171		0.0188				28.1	43.34	58.21		0.0229	0.0308	0.0537	
81	0.078	6250	9.75			114301		0.0187				28.1	43.16	58.21		0.0235	0.0316	0.0551	
82	0.076	6250	9.75			111466		0.0188				28.1	43.33	58.21		0.0230	0.0309	0.0538	
83	0.076	6250	9.75			111466		0.0188				28.1	43.33	58.21		0.0230	0.0309	0.0538	
84	0.076	6250	9.75			111466		0.0188				28.1	43.33	58.21		0.0230	0.0309	0.0538	
85	0.076	6250	9.75			111618		0.0188				28.1	43.32	58.21		0.0230	0.0309	0.0539	
87	0.078	6250	9.75			113230		0.0188				28.1	43.22	58.21		0.0233	0.0313	0.0546	
91	0.076	6250	9.75			111171		0.0188				28.1	43.34	58.21		0.0229	0.0308	0.0537	
92	0.080	6250	9.75			117262		0.0187				28.1	42.99	58.21		0.0240	0.0325	0.0564	
93	0.077	6250	9.75			113158		0.0188				28.1	43.22	58.21		0.0233	0.0313	0.0546	
94	0.076	6250	9.75			111353		0.0188				28.1	43.33	58.21		0.0229	0.0308	0.0538	
95	0.076	6250	9.75			111480		0.0188				28.1	43.33	58.21		0.0230	0.0309	0.0538	
100	0.076	6250	9.75			111668		0.0188				28.1	43.31	58.21		0.0230	0.0309	0.0539	
101	0.077	6250	9.75			111817		0.0188				28.1	43.31	58.21		0.0230	0.0310	0.0540	
111	0.078	6250	9.75			113623		0.0187				28.1	43.20	58.21		0.0233	0.0315	0.0548	
112	0.103	6250	9.75			150431		0.0180				28.1	41.44	58.21		0.0296	0.0416	0.0713	
113	0.079	6250	9.75			115454		0.0187				28.1	43.09	58.21		0.0237	0.0320	0.0556	
119	0.077	6250	9.75			112118		0.0188				28.1	43.29	58.21		0.0231	0.0310	0.0541	
124	0.076	6250	9.75			111171		0.0188				28.1	43.34	58.21		0.0229	0.0308	0.0537	
128	0.077	6250	9.75			112091		0.0188				28.1	43.29	58.21		0.0231	0.0310	0.0541	
130	0.076	6250	9.75			111171		0.0188				28.1	43.34	58.21		0.0229	0.0308	0.0537	
131	0.078	6250	9.75			113848		0.0187				28.1	43.18	58.21		0.0234	0.0315	0.0549	
132	0.076	6250	9.75			111467		0.0188				28.1	43.33	58.21		0.0230	0.0309	0.0538	
133	0.076	6250	9.75			111504		0.0188				28.1	43.32	58.21		0.0230	0.0309	0.0538	
134	0.076	6250	9.75			111505		0.0188				28.1	43.32	58.21		0.0230	0.0309	0.0538	

547	0.083	6250	9.75			120482			0.0186			28.1					42.81	58.21					0.0245	0.0334	0.0579
548	0.081	6250	9.75			118474			0.0186			28.1					42.92	58.21					0.0242	0.0328	0.0570
549	0.083	6250	9.75			120482			0.0186			28.1					42.81	58.21					0.0245	0.0334	0.0579
550	0.077	6250	9.75			112997			0.0188			28.1					#REF!	58.21					0.0232	0.0313	0.0545

Notes: 1) Vapor flow rate used in loading condition is vapor equivalent loading rate including vapor growth rate
2) Air equivalent flow rate derived from maximum liquid discharge rate and a density correction factor for conservatism (see list of allowable cargoes for details)

MAX ΔP: 0.3433

Maximum design pressure of tank: 3.00 psi

Loading (Pressure) Summary:

Cargo	Piping ΔP	Vapor Flowrate	Air Equivalent Flowrate		ΔP across P-V ¹		Total Vapor ΔP thru P-V system
	psi	BBL/hr	BBL/hr	ft ³ /hr	kPa	psi	psi
Acetone	0.084	6250	7949	44632	n/a	2.23	2.314
Acetophenone	0.060	6250	6604	37079	n/a	2.23	2.290
Amyl Acetate (iso-)	0.057	6250	6468	36317	n/a	2.23	2.287
Amyl Alcohol (iso-, no, sec-, primary) (See also IAA)	0.056	6250	6367	35751	n/a	2.23	2.286
Amyl Alcohol (n-)	0.056	6250	6367	35751	n/a	2.23	2.286
Amyl Alcohol, Primary	0.056	6250	6367	35751	n/a	2.23	2.286
Amyl Alcohol, (sec-)	0.056	6250	6367	35751	n/a	2.23	2.286
Amyl Alcohol, (iso-)	0.056	6250	6367	35751	n/a	2.23	2.286
Benzyl Alcohol	0.055	6250	6303	35389	n/a	2.23	2.285
Butyl Acetate (iso- n-)	0.059	6250	6588	36993	n/a	2.23	2.289
Butyl Acetate (sec-)	0.068	6250	7065	39671	n/a	2.23	2.298
Butyl AlCOhol (iso-)	0.058	6250	6522	36621	n/a	2.23	2.288
Butyl AlCOhol (sec-)	0.060	6250	6639	37279	n/a	2.23	2.290
Butyl Alcohol (tert-)	0.067	6250	7062	39652	n/a	2.23	2.297
Butyl Benzyl Phthalate	0.054	6250	6269	35200	n/a	2.23	2.284
Butyl Toluene	0.055	6250	6329	35537	n/a	2.23	2.285
Caprolactam Solutions	0.054	6250	6278	35251	n/a	2.23	2.284
Cumene	0.060	6250	6610	37116	n/a	2.23	2.290
Cyclohexane	0.080	6250	7726	43379	n/a	2.23	2.310
Cyclohexanol	0.055	6250	6321	35490	n/a	2.23	2.285
1,3-Cyclopentadiene dimer (molten)	0.056	6250	6419	36043	n/a	2.23	2.286
Cymene (para-)	0.055	6250	6326	35523	n/a	2.23	2.285
Decahydronaphthalene	0.055	6250	6322	35499	n/a	2.23	2.285
Decaldehyde (iso-)	0.054	6250	6258	35137	n/a	2.23	2.284
Decaldehyde (n-)	0.054	6250	6250	35094	n/a	2.23	2.284
Decane	0.055	6250	6337	35585	n/a	2.23	2.285
Decyl Alcohol (all isomers) (Decanol)	0.054	6250	6258	35141	n/a	2.23	2.284
Decyl Alcohol (iso-)	0.054	6250	6258	35141	n/a	2.23	2.284
Decyl Alcohol (n-)	0.054	6250	6258	35141	n/a	2.23	2.284
Decylbenzene (n-)	0.054	6250	6263	35165	n/a	2.23	2.284
Diacetone Alcohol	0.055	6250	6308	35418	n/a	2.23	2.285
Dibutyl Phthalate (ortho-)	0.054	6250	6250	35094	n/a	2.23	2.284
Dicyclopentadlene, See 1,3-Cyclopentadlene Dimer (mo	0.056	6250	6419	36043	n/a	2.23	2.286
Diethybenzene	0.055	6250	6306	35406	n/a	2.23	2.285
Diethylene Glycol	0.054	6250	6255	35123	n/a	2.23	2.284
Diethylene Glycol Butyl Ether	0.054	6250	6259	35143	n/a	2.23	2.284
Diethylene Glycol Ethyl Ether Acetate	0.054	6250	6264	35172	n/a	2.23	2.284
Diethylene Glycol Methyl Ether	0.054	6250	6268	35196	n/a	2.23	2.284
Diisobutylcarbinol	0.055	6250	6319	35479	n/a	2.23	2.285
Diisobutylene	0.071	6250	7270	40823	n/a	2.23	2.301
Diisobutyl Ketone	0.056	6250	6369	35764	n/a	2.23	2.286
Diisopropylbenzene (all isomer)	0.054	6250	6277	35243	n/a	2.23	2.284
Dimethyl Phthalate	0.054	6250	6250	35094	n/a	2.23	2.284
Dinonyl Phthalate	0.054	6250	6276	35239	n/a	2.23	2.284
Diocetyl Phthalate	0.054	6250	6250	35094	n/a	2.23	2.284
Dipentene	0.055	6250	6325	35514	n/a	2.23	2.285
Diphenyl	0.054	6250	6258	35141	n/a	2.23	2.284
Diphenyl, Diphenyl Ether Mixture	0.054	6250	6259	35147	n/a	2.23	2.284
Diphenyl Ether	0.054	6250	6259	35147	n/a	2.23	2.284
Dipropylene GLYCOL	0.054	6250	6299	35368	n/a	2.23	2.284
Distillates: Flashed Feed Stocks	0.071	6250	7237	40637	n/a	2.23	2.301
Distillates: Straight Run	0.071	6250	7237	40637	n/a	2.23	2.301
Dodecene (all isomers)	0.054	6250	6269	35198	n/a	2.23	2.284

Dodecene	0.054	6250	6269	35198	n/a	2.23	2.284
Dodecylbenzene	0.159	6250	11088	62259	n/a	2.23	2.389
Ethoxy Triglycol (crude)	0.054	6250	6250	35094	n/a	2.23	2.284
Ethyl Acetate	0.082	6250	7823	43928	n/a	2.23	2.312
Ethyl Acetoacetate	0.056	6250	6383	35840	n/a	2.23	2.286
Ethyl Alcohol (Ethanol)	0.060	6250	6643	37300	n/a	2.23	2.290
Ethyl Benzene	0.058	6250	6540	36720	n/a	2.23	2.288
Ethyl Butanol	0.055	6250	6308	35420	n/a	2.23	2.285
Ethyl Butyrate	0.063	6250	6804	38206	n/a	2.23	2.293
Ethyl Cyclohexane	0.058	6250	6521	36616	n/a	2.23	2.288
Ethylene Glycol	0.054	6250	6252	35107	n/a	2.23	2.284
Ethylene Glycol Butyl Ether Acetate	0.054	6250	6294	35338	n/a	2.23	2.284
Ethylene Glycol Diacetate	0.054	6250	6258	35138	n/a	2.23	2.284
Ethylene Glycol Methyl Ether	0.054	6250	6257	35135	n/a	2.23	2.284
Ethylene Glycol Phenyl Ether	0.054	6250	6257	35135	n/a	2.23	2.284
2-Ethylhexaldehyde, See Octyl Aldehydes	0.055	6250	6361	35717	n/a	2.23	2.285
2-Ethylhexanol , see Octanol (all isomers)	0.054	6250	6264	35170	n/a	2.23	2.284
Ethyl Propionate	0.060	6250	6643	37300	n/a	2.23	2.290
Ethyl Toulene	0.056	6250	6418	36037	n/a	2.23	2.286
Formamide	0.054	6250	6261	35154	n/a	2.23	2.284
Furfuryl Alcohol	0.054	6250	6273	35224	n/a	2.23	2.284
Gasoline Blended Stocks: Alkylates	0.145	6250	10555	59268	n/a	2.23	2.375
Gasoline Blended Stocks: Reformate	0.145	6250	10555	59268	n/a	2.23	2.375
Gasolines: Automotive (containing not over 4.23 grams	0.145	6250	10555	59268	n/a	2.23	2.375
Gasolines: Aviation (containing not over 4.86 grams lead	0.145	6250	10555	59268	n/a	2.23	2.375
Gasolines: Casinghead	0.145	6250	10555	59268	n/a	2.23	2.375
Gasolines: Polymer	0.145	6250	10555	59268	n/a	2.23	2.375
Gasolines: Straight Run	0.145	6250	10555	59268	n/a	2.23	2.375
Glycerine	0.054	6250	6250	35094	n/a	2.23	2.284
Heptane (all isomers) (Methylhexane)	0.073	6250	7337	41199	n/a	2.23	2.303
Heptane (n-)	0.073	6250	7337	41199	n/a	2.23	2.303
Heptonic Acid	0.054	6250	6257	35132	n/a	2.23	2.284
Heptanol (all isomers)	0.054	6250	6273	35224	n/a	2.23	2.284
Heptanol (all isomers)	0.054	6250	6273	35224	n/a	2.23	2.284
Heptene (all isomers)	0.075	6250	7473	41962	n/a	2.23	2.305
Heptene (1-)	0.074	6250	7434	41744	n/a	2.23	2.304
Heptyl Acetate	0.055	6250	6336	35578	n/a	2.23	2.285
Hexane (all isomers)	0.097	6250	8534	47918	n/a	2.23	2.327
Hexane	0.097	6250	8534	47918	n/a	2.23	2.327
Hexanoic Acid	0.054	6250	6256	35127	n/a	2.23	2.284
Hexanol	0.061	6250	6719	37725	n/a	2.23	2.291
Hexene (all isomers)	0.100	6250	8702	48861	n/a	2.23	2.330
Hexene (1-)	0.101	6250	8754	49156	n/a	2.23	2.331
Hexene (2-)	0.101	6250	8754	49156	n/a	2.23	2.331
Hexylene Glycol	0.054	6250	6250	35095	n/a	2.23	2.284
isophorone	0.054	6250	6257	35135	n/a	2.23	2.284
Jet Fuels: JP-1 (Kerosene)	0.055	6250	6344	35621	n/a	2.23	2.285
Jet Fuels: JP-3	0.144	6250	10531	59130	n/a	2.23	2.374
Jet Fuels: JP-4	0.085	6250	7979	44802	n/a	2.23	2.315
Jet Fuels: JP-5 (Kerosene, heavy)	0.055	6250	6308	35418	n/a	2.23	2.285
Kerosene	0.055	6250	6351	35658	n/a	2.23	2.285
Methyl Acetate	0.084	6250	7912	44427	n/a	2.23	2.314
Methyl Alcohol (See Methanol)	0.056	6250	6377	35805	n/a	2.23	2.286
Methyl Amyl Acetate	0.058	6250	6498	36486	n/a	2.23	2.288
Methyl Amyl Alcohol	0.057	6250	6456	36249	n/a	2.23	2.287
Methyl n-Butyl Ketone	0.061	6250	6702	37630	n/a	2.23	2.291
Methyl Butyrate	0.064	6250	6838	38393	n/a	2.23	2.294
Methyl Ethyl Ketone	0.074	6250	7439	41771	n/a	2.23	2.304
Methyl Formal (Dimethyl Formal)	0.152	6542	10805	60671	n/a	2.23	2.382
Methyl Heptyl Ketone	0.054	6250	6295	35347	n/a	2.23	2.284

Methyl Isobutyl Ketone	0.062	6250	6772	38024	n/a	2.23	2.292
1-Methyl Naphthalene	0.054	6250	6258	35136	n/a	2.23	2.284
2-Methyl-1-Pentene	0.090	6250	8242	46279	n/a	2.23	2.320
5-Methyl-1-Pentene	0.103	6250	8830	49580	n/a	2.23	2.333
Methyl Tert-Butyl Ether (MTBE)	0.054	6250	6266	35185	n/a	2.23	2.284
Mineral Spirits	0.056	6250	6376	35802	n/a	2.23	2.286
Myrcene	0.056	6250	6370	35769	n/a	2.23	2.286
Naphtha: Solvent	0.055	6250	6346	35632	n/a	2.23	2.285
Naphtha: Stoddard Solvant	0.056	6250	6376	35802	n/a	2.23	2.286
Naphtha: Vamish Maker's and Painters (75%)	0.056	6250	6370	35767	n/a	2.23	2.286
Nonane (all isomers)	0.057	6250	6425	36075	n/a	2.23	2.287
Nonane	0.057	6250	6425	36075	n/a	2.23	2.287
Nonene	0.057	6250	6469	36324	n/a	2.23	2.287
Nonyl Alcohol (all isomers)	0.055	6250	6327	35525	n/a	2.23	2.285
Nonyl Alcohol	0.055	6250	6327	35525	n/a	2.23	2.285
Nonyl Alcohol (iso-)	0.055	6250	6327	35525	n/a	2.23	2.285
Nonyl Phenol	0.054	6250	6263	35165	n/a	2.23	2.284
Octane (all isomers)	0.061	6250	6677	37494	n/a	2.23	2.291
Octane	0.061	6250	6677	37494	n/a	2.23	2.291
Octanoic Acid (all isomers)	0.054	6250	6258	35137	n/a	2.23	2.284
Octanol (all isomers)	0.054	6250	6257	35132	n/a	2.23	2.284
Octanol	0.054	6250	6257	35132	n/a	2.23	2.284
Octene (all isomers) 2	0.062	6250	6735	37816	n/a	2.23	2.292
Octene (1-)	0.063	6250	6779	38067	n/a	2.23	2.293
Octyl Alcohol (iso-,n.) (all isomers), See Octanol (all isomers)	0.054	6250	6257	35132	n/a	2.23	2.284
Octyl Alcohol	0.054	6250	6257	35132	n/a	2.23	2.284
Fuel: NO.2	0.066	6250	6965	39111	n/a	2.23	2.296
Fuel: NO.4	0.055	6250	6319	35482	n/a	2.23	2.285
Fuel: No.5	0.055	6250	6319	35482	n/a	2.23	2.285
Fuel: NO.6	0.055	6250	6319	35482	n/a	2.23	2.285
OIL, Mise: Crude	0.055	6250	6319	35482	n/a	2.23	2.285
Oil, Mise: Diesel	0.059	6250	6562	36844	n/a	2.23	2.289
OIL, Mise: Lubricating	0.054	6250	6250	35094	n/a	2.23	2.284
OIL, Mise: Resin	0.054	6250	6250	35094	n/a	2.23	2.284
Oil, Mise: Turbine	0.058	6250	6500	36496	n/a	2.23	2.288
Pentadecanol, See Alcohols (C13 and above)	0.054	6250	6263	35169	n/a	2.23	2.284
Pentane (all isomers)	0.229	7100	13366	75047	n/a	2.23	2.459
Pentane (iso-)	0.343	7700	16436	92286	n/a	2.23	2.573
Pentane (n-)	0.222	7044	13135	73751	n/a	2.23	2.452
Pentene (all isomers)	0.291	7490	15104	84806	n/a	2.23	2.521
Pentene (1-)	0.291	7490	15104	84806	n/a	2.23	2.521
Pinene	0.058	6250	6495	36470	n/a	2.23	2.288
Polybutene	0.056	6250	6399	35932	n/a	2.23	2.286
Polypropylene Glycol	0.054	6250	6250	35094	n/a	2.23	2.284
Polypropylene Glycol Methyl Ether	0.059	6250	6568	36877	n/a	2.23	2.289
Propyl Acetate (iso-)	0.068	6250	7071	39705	n/a	2.23	2.298
Propyl Acetate (n-)	0.068	6250	7093	39826	n/a	2.23	2.298
Propyl Alcohol (iso-)	0.064	6250	6841	38415	n/a	2.23	2.294
Propyl Alcohol (n-)	0.058	6250	6493	36459	n/a	2.23	2.288
Propylbenzene (n-)	0.056	6250	6370	35768	n/a	2.23	2.286
iso-Propylcyclohexane	0.054	6250	6257	35130	n/a	2.23	2.284
Propylene Glycol (1,2-Propandiol)	0.054	6250	6253	35112	n/a	2.23	2.284
Propylene Glycol Methyl Ether	0.058	6250	6529	36659	n/a	2.23	2.288
Propylene Tetramer	0.054	6250	6250	35094	n/a	2.23	2.284
Sulfolane	0.054	6250	6256	35128	n/a	2.23	2.284
Tetradecanol	0.054	6250	6250	35094	n/a	2.23	2.284
1-Tetradecene, See the olefin or Alpha-Olefin Entries	0.054	6250	6261	35157	n/a	2.23	2.284
Tetraethylene Glycol	0.054	6250	6261	35156	n/a	2.23	2.284
Tetrahydronaphthalene	0.054	6250	6278	35248	n/a	2.23	2.284
Toluene	0.064	6250	6841	38415	n/a	2.23	2.294

Tricresyl Phosphate (less than 1% of the ortho isomer)	0.054	6250	6273	35220	n/a	2.23	2.284
Tridecane	0.054	6250	6271	35211	n/a	2.23	2.284
Tridecanol , See Alcohols (C13 and above)	0.054	6250	6261	35158	n/a	2.23	2.284
l-Tridecene	0.054	6250	6260	35151	n/a	2.23	2.284
Triethylbenzene	0.054	6250	6268	35194	n/a	2.23	2.284
Triethylene Glycol	0.054	6250	6258	35139	n/a	2.23	2.284
Trimethylbenzenes (all isomers)	0.055	6250	6336	35576	n/a	2.23	2.285
Trimethyl Benzene (1,2,5-)	0.055	6250	6334	35567	n/a	2.23	2.285
Trimethyl Benzene (1,2,3-)	0.055	6250	6334	35567	n/a	2.23	2.285
Trimethyl Benzene (1,2,4-) (Pseudocumene)	0.055	6250	6334	35567	n/a	2.23	2.285
Trixylenyl Phosphate	0.054	6250	6250	35094	n/a	2.23	2.284
Undecene (1-)	0.054	6250	6292	35327	n/a	2.23	2.284
Undecyl Alcohol	0.054	6250	6260	35148	n/a	2.23	2.284
Xylenes (Ortho-, meta-, para-)	0.058	6250	6507	36534	n/a	2.23	2.288
Xylene (M-)	0.058	6250	6507	36534	n/a	2.23	2.288
Xylene (O-)	0.057	6250	6452	36228	n/a	2.23	2.287
Xylene (P-)	0.058	6250	6507	36534	n/a	2.23	2.288
Xylenol	0.055	6250	6301	35381	n/a	2.23	2.285
Zinc Dialkyldithiophosphate	0.000	0	0	0	n/a	2.23	2.230

Cargo with the highest pressure drop is:

Pentane (iso-)	Max ΔP =	2.57 psi	<	3.00 psi	OK
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Notes: 1) See ERL flow curve "180U172B"

Discharge (Vacuum) Summary:

Cargo	Piping ΔP	Vapor Flowrate ¹	Air Equivalent Flowrate ²		ΔP across P-V ³		Total Vapor ΔP thru P-V system
	psi	BBL/hr	BBL/hr	ft ³ /hr	kPa	psi	psi
Acetone	0.055	5000	6359	35705	n/a	0.50	0.555
Acetophenone	0.039	5000	5283	29663	n/a	0.50	0.539
Amyl Acetate (iso-)	0.037	5000	5174	29054	n/a	0.50	0.537
Amyl Alcohol (iso-, no, sec-, primary) (See also IAA)	0.036	5000	5094	28601	n/a	0.50	0.536
Amyl Alcohol (n-)	0.036	5000	5094	28601	n/a	0.50	0.536
Amyl Alcohol, Primary	0.036	5000	5094	28601	n/a	0.50	0.536
Amyl Alcohol, (sec-)	0.036	5000	5094	28601	n/a	0.50	0.536
Amyl Alcohol, (iso-)	0.036	5000	5094	28601	n/a	0.50	0.536
Benzyl Alcohol	0.035	5000	5042	28311	n/a	0.50	0.535
Butyl Acetate (iso-, n-)	0.038	5000	5271	29594	n/a	0.50	0.538
Butyl Acetate (sec-)	0.044	5000	5652	31737	n/a	0.50	0.544
Butyl AlCOhol (iso-)	0.038	5000	5218	29297	n/a	0.50	0.538
Butyl AlCOhol (sec-)	0.039	5000	5311	29824	n/a	0.50	0.539
Butyl Alcohol (tert-)	0.044	5000	5649	31721	n/a	0.50	0.544
Butyl Benzyl Phthalate	0.035	5000	5015	28160	n/a	0.50	0.535
Butyl Toluene	0.036	5000	5063	28429	n/a	0.50	0.536
Caprolactam Solutions	0.035	5000	5022	28201	n/a	0.50	0.535
Cumene	0.039	5000	5288	29693	n/a	0.50	0.539
Cyclohexane	0.052	5000	6180	34703	n/a	0.50	0.552
Cyclohexanol	0.036	5000	5056	28392	n/a	0.50	0.536
1,3-Cyclopentadiene dimer (molten)	0.037	5000	5135	28834	n/a	0.50	0.537
Cymene (para-)	0.036	5000	5061	28418	n/a	0.50	0.536
Decahydronaphthalene	0.036	5000	5058	28399	n/a	0.50	0.536
Decaldehyde (iso-)	0.035	5000	5006	28110	n/a	0.50	0.535
Decaldehyde (n-)	0.035	5000	5000	28075	n/a	0.50	0.535
Decane	0.036	5000	5070	28468	n/a	0.50	0.536
Decyl Alcohol (all isomers) (Decanol)	0.035	5000	5007	28112	n/a	0.50	0.535
Decyl Alcohol (iso-)	0.035	5000	5007	28112	n/a	0.50	0.535
Decyl Alcohol (n-)	0.035	5000	5007	28112	n/a	0.50	0.535
Decylbenzene (n-)	0.035	5000	5010	28132	n/a	0.50	0.535
Diacetone Alcohol	0.035	5000	5046	28334	n/a	0.50	0.535
Dibutyl Phthalate (ortho-)	0.035	5000	5000	28075	n/a	0.50	0.535
Dicyclopentadlene, See 1,3-Cyclopentadlene Dimer (mo	0.037	5000	5135	28834	n/a	0.50	0.537
Diethybenzene	0.035	5000	5045	28325	n/a	0.50	0.535
Diethylene Glycol	0.035	5000	5004	28098	n/a	0.50	0.535
Diethylene Glycol Butyl Ether	0.035	5000	5007	28114	n/a	0.50	0.535
Diethylene Glycol Ethyl Ether Acetate	0.035	5000	5011	28138	n/a	0.50	0.535
Diethylene Glycol Methyl Ether	0.035	5000	5015	28157	n/a	0.50	0.535
DiisobutylcarbInol	0.036	5000	5055	28383	n/a	0.50	0.536
Diisobutylene	0.046	5000	5816	32659	n/a	0.50	0.546
Disobutyl Ketone	0.036	5000	5095	28611	n/a	0.50	0.536
Diisopropylbenzene (all isomer)	0.035	5000	5021	28195	n/a	0.50	0.535
Dimethyl Phthalate	0.035	5000	5000	28075	n/a	0.50	0.535
Dinonyl Phthalate	0.035	5000	5021	28191	n/a	0.50	0.535
Dioctyl Phthalate	0.035	5000	5000	28075	n/a	0.50	0.535
Dipentene	0.036	5000	5060	28411	n/a	0.50	0.536
Diphenyl	0.035	5000	5007	28113	n/a	0.50	0.535
Diphenyl, Diphenyl Ether Mixture	0.035	5000	5008	28117	n/a	0.50	0.535
Diphenyl Ether	0.035	5000	5008	28117	n/a	0.50	0.535
Dipropylene GLYCOL	0.035	5000	5039	28295	n/a	0.50	0.535
Distillates: Flashed Feed Stocks	0.046	5000	5790	32509	n/a	0.50	0.546
Distillates: Straight Run	0.046	5000	5790	32509	n/a	0.50	0.546

Dodecene (all isomers)	0.035	5000	5015	28159	n/a	0.50	0.535
Dodecene	0.035	5000	5015	28159	n/a	0.50	0.535
Dodecylbenzene	0.103	5000	8870	49807	n/a	0.50	0.603
Ethoxy Triglycol (crude)	0.035	5000	5000	28075	n/a	0.50	0.535
Ethyl Acetate	0.053	5000	6259	35142	n/a	0.50	0.553
Ethyl Acetoacetate	0.036	5000	5106	28672	n/a	0.50	0.536
Ethyl Alcohol (Ethanol)	0.039	5000	5314	29840	n/a	0.50	0.539
Ethyl Benzene	0.038	5000	5232	29376	n/a	0.50	0.538
Ethyl Butanol	0.036	5000	5047	28336	n/a	0.50	0.536
Ethyl Butyrate	0.041	5000	5443	30565	n/a	0.50	0.541
Ethyl Cyclohexane	0.038	5000	5217	29293	n/a	0.50	0.538
Ethylene Glycol	0.035	5000	5002	28086	n/a	0.50	0.535
Ethylene Glycol Butyl Ether Acetate	0.035	5000	5035	28270	n/a	0.50	0.535
Ethylene Glycol Diacetate	0.035	5000	5006	28110	n/a	0.50	0.535
Ethylene Glycol Methyl Ether	0.035	5000	5006	28108	n/a	0.50	0.535
Ethylene Glycol Phenyl Ether	0.035	5000	5006	28108	n/a	0.50	0.535
2-Ethylhexaldehyde, See Octyl Aldehydes	0.036	5000	5089	28573	n/a	0.50	0.536
2-Ethylhexanol , see Octanol (all isomers)	0.035	5000	5011	28136	n/a	0.50	0.535
Ethyl Propionate	0.039	5000	5314	29840	n/a	0.50	0.539
Ethyl Toulene	0.037	5000	5134	28830	n/a	0.50	0.537
Formamide	0.035	5000	5009	28123	n/a	0.50	0.535
Furfuryl Alcohol	0.035	5000	5019	28179	n/a	0.50	0.535
Gasoline Blended Stocks: Alkylates	0.094	5000	8444	47415	n/a	0.50	0.594
Gasoline Blended Stocks: Reformate	0.094	5000	8444	47415	n/a	0.50	0.594
Gasolines: Automotive (containing not over 4.23 grams	0.094	5000	8444	47415	n/a	0.50	0.594
Gasolines: Aviation (containing not over 4.86 grams lead	0.094	5000	8444	47415	n/a	0.50	0.594
Gasolines: Casinghead	0.094	5000	8444	47415	n/a	0.50	0.594
Gasolines: Polymer	0.094	5000	8444	47415	n/a	0.50	0.594
Gasolines: Straight Run	0.094	5000	8444	47415	n/a	0.50	0.594
Glycerine	0.035	5000	5000	28075	n/a	0.50	0.535
Heptane (all isomers) (Methylhexane)	0.047	5000	5870	32959	n/a	0.50	0.547
Heptane (n-)	0.047	5000	5870	32959	n/a	0.50	0.547
Heptonic Acid	0.035	5000	5005	28105	n/a	0.50	0.535
Heptanol (all isomers)	0.035	5000	5019	28179	n/a	0.50	0.535
Heptanol (all isomers)	0.035	5000	5019	28179	n/a	0.50	0.535
Heptene (all isomers)	0.049	5000	5979	33570	n/a	0.50	0.549
Heptene (1-)	0.048	5000	5948	33395	n/a	0.50	0.548
Heptyl Acetate	0.036	5000	5069	28463	n/a	0.50	0.536
Hexane (all isomers)	0.063	5000	6827	38334	n/a	0.50	0.563
Hexane	0.063	5000	6827	38334	n/a	0.50	0.563
Hexanoic Acid	0.035	5000	5005	28101	n/a	0.50	0.535
Hexanol	0.040	5000	5375	30180	n/a	0.50	0.540
Hexene (all isomers)	0.065	5000	6961	39089	n/a	0.50	0.565
Hexene (1-)	0.066	5000	7004	39324	n/a	0.50	0.566
Hexene (2-)	0.066	5000	7004	39324	n/a	0.50	0.566
Hexylene Glycol	0.035	5000	5000	28076	n/a	0.50	0.535
isophorone	0.035	5000	5006	28108	n/a	0.50	0.535
Jet Fuels: JP-1 (Kerosene)	0.036	5000	5075	28497	n/a	0.50	0.536
Jet Fuels: JP-3	0.093	5000	8425	47304	n/a	0.50	0.593
Jet Fuels: JP-4	0.055	5000	6383	35841	n/a	0.50	0.555
Jet Fuels: JP-5 (Kerosene, heavy)	0.035	5000	5046	28334	n/a	0.50	0.535
Kerosene	0.036	5000	5080	28527	n/a	0.50	0.536
Methyl Acetate	0.054	5000	6330	35541	n/a	0.50	0.554
Methyl Alcohol (See Methanol)	0.036	5000	5101	28644	n/a	0.50	0.536
Methyl Amyl Acetate	0.038	5000	5198	29189	n/a	0.50	0.538
Methyl Amyl Alcohol	0.037	5000	5165	28999	n/a	0.50	0.537
Methyl n-Butyl Ketone	0.040	5000	5361	30104	n/a	0.50	0.540
Methyl Butyrate	0.041	5000	5470	30714	n/a	0.50	0.541
Methyl Ethyl Ketone	0.048	5000	5951	33417	n/a	0.50	0.548
Methyl Formal (Dimethyl Formal)	0.090	5000	8258	46370	n/a	0.50	0.590

Methyl Heptyl Ketone	0.035	5000	5036	28277	n/a	0.50	0.535
Methyl Isobutyl Ketone	0.041	5000	5418	30419	n/a	0.50	0.541
1-Methyl Naphthalene	0.035	5000	5006	28109	n/a	0.50	0.535
2-Methyl-1-Pentene	0.059	5000	6594	37023	n/a	0.50	0.559
5-Methyl-1-Pentene	0.067	5000	7064	39664	n/a	0.50	0.567
Methyl Tert-Butyl Ether (MTBE)	0.035	5000	5013	28148	n/a	0.50	0.535
Mineral Spirits	0.036	5000	5101	28642	n/a	0.50	0.536
Myrcene	0.036	5000	5096	28615	n/a	0.50	0.536
Naphtha: Solvent	0.036	5000	5077	28505	n/a	0.50	0.536
Naphtha: Stoddard Solvant	0.036	5000	5101	28642	n/a	0.50	0.536
Naphtha: Vamlsh Maker's and Painters (75%)	0.036	5000	5096	28614	n/a	0.50	0.536
Nonane (all isomers)	0.037	5000	5140	28860	n/a	0.50	0.537
Nonane	0.037	5000	5140	28860	n/a	0.50	0.537
Nonene	0.037	5000	5175	29059	n/a	0.50	0.537
Nonyl Alcohol (all isomers)	0.036	5000	5061	28420	n/a	0.50	0.536
Nonyl Alcohol	0.036	5000	5061	28420	n/a	0.50	0.536
Nonyl Alcohol (iso-)	0.036	5000	5061	28420	n/a	0.50	0.536
Nonyl Phenol	0.035	5000	5010	28132	n/a	0.50	0.535
Octane (all isomers)	0.039	5000	5342	29995	n/a	0.50	0.539
Octane	0.039	5000	5342	29995	n/a	0.50	0.539
Octanoic Acid (all isomers)	0.035	5000	5006	28110	n/a	0.50	0.535
Octanol (all isomers)	0.035	5000	5005	28105	n/a	0.50	0.535
Octanol	0.035	5000	5005	28105	n/a	0.50	0.535
Octene (all isomers) 2	0.040	5000	5388	30253	n/a	0.50	0.540
Octene (1-)	0.041	5000	5424	30453	n/a	0.50	0.541
Octyl Alcohol (iso-,n.) (all isomers), See Octanol (all isomers)	0.035	5000	5005	28105	n/a	0.50	0.535
Octyl Alcohol	0.035	5000	5005	28105	n/a	0.50	0.535
Fuel: NO.2	0.043	5000	5572	31289	n/a	0.50	0.543
Fuel: NO.4	0.036	5000	5055	28386	n/a	0.50	0.536
Fuel: No.5	0.036	5000	5055	28386	n/a	0.50	0.536
Fuel: NO.6	0.036	5000	5055	28386	n/a	0.50	0.536
OIL, Mise: Crude	0.036	5000	5055	28386	n/a	0.50	0.536
Oil, Mise: Diesel	0.038	5000	5249	29476	n/a	0.50	0.538
OIL, Mise: Lubricating	0.035	5000	5000	28075	n/a	0.50	0.535
OIL, Mise: Resin	0.035	5000	5000	28075	n/a	0.50	0.535
Oil, Mise: Turbine	0.038	5000	5200	29197	n/a	0.50	0.538
Pentadecanol, See Alcohols (C13 and above)	0.035	5000	5011	28135	n/a	0.50	0.535
Pentane (all isomers)	0.115	5000	9412	52850	n/a	0.50	0.615
Pentane (iso-)	0.147	5000	10673	59926	n/a	0.50	0.647
Pentane (n-)	0.113	5000	9323	52350	n/a	0.50	0.613
Pentene (all isomers)	0.131	5000	10082	56613	n/a	0.50	0.631
Pentene (1-)	0.131	5000	10082	56613	n/a	0.50	0.631
Pinene	0.037	5000	5196	29176	n/a	0.50	0.537
Polybutene	0.036	5000	5120	28746	n/a	0.50	0.536
Polypropylene Glycol	0.035	5000	5000	28075	n/a	0.50	0.535
Polypropylene Glycol Methyl Ether	0.038	5000	5254	29502	n/a	0.50	0.538
Propyl Acetate (iso-)	0.044	5000	5657	31764	n/a	0.50	0.544
Propyl Acetate (n-)	0.044	5000	5674	31861	n/a	0.50	0.544
Propyl Alcohol (iso-)	0.041	5000	5473	30732	n/a	0.50	0.541
Propyl Alcohol (n-)	0.037	5000	5194	29167	n/a	0.50	0.537
Propylbenzene (n-)	0.036	5000	5096	28614	n/a	0.50	0.536
iso-Propylcyclohexane	0.035	5000	5005	28104	n/a	0.50	0.535
Propylene Glycol (1,2-Propandiol)	0.035	5000	5003	28089	n/a	0.50	0.535
Propylene Glycol Methyl Ether	0.038	5000	5223	29327	n/a	0.50	0.538
Propylene Tetramer	0.035	5000	5000	28075	n/a	0.50	0.535
Sulfolane	0.035	5000	5005	28102	n/a	0.50	0.535
Tetradecanol	0.035	5000	5000	28075	n/a	0.50	0.535
1-Tetradecene, See the olefin or Alpha-Olefin Entries	0.035	5000	5009	28125	n/a	0.50	0.535
Tetraethylene Glycol	0.035	5000	5009	28125	n/a	0.50	0.535
Tetrahydronaphthalene	0.035	5000	5022	28198	n/a	0.50	0.535

Toluene	0.041	5000	5473	30732	n/a	0.50	0.541
Tricresyl Phosphate (less than 1% of the ortho isomer)	0.035	5000	5018	28176	n/a	0.50	0.535
Tridecane	0.035	5000	5017	28169	n/a	0.50	0.535
Tridecanol , See Alcohols (C13 and above)	0.035	5000	5009	28126	n/a	0.50	0.535
l-Tridecene	0.035	5000	5008	28121	n/a	0.50	0.535
Triethylbenzene	0.035	5000	5014	28155	n/a	0.50	0.535
Triethylene Glycol	0.035	5000	5007	28111	n/a	0.50	0.535
Trimethylbenzenes (all isomers)	0.036	5000	5069	28461	n/a	0.50	0.536
Trimethyl Benzene (1,2,5-)	0.036	5000	5067	28454	n/a	0.50	0.536
Trimethyl Benzene (1,2,3-)	0.036	5000	5067	28454	n/a	0.50	0.536
Trimethyl Benzene (1,2,4-) (Pseudocumene)	0.036	5000	5067	28454	n/a	0.50	0.536
Trixylenyl Phosphate	0.035	5000	5000	28075	n/a	0.50	0.535
Undecene (1-)	0.035	5000	5033	28262	n/a	0.50	0.535
Undecyl Alcohol	0.035	5000	5008	28118	n/a	0.50	0.535
Xylenes (Ortho-, meta., para-)	0.038	5000	5205	29227	n/a	0.50	0.538
Xylene (M-)	0.038	5000	5205	29227	n/a	0.50	0.538
Xylene (O-)	0.037	5000	5162	28983	n/a	0.50	0.537
Xylene (P-)	0.038	5000	5205	29227	n/a	0.50	0.538
Xylenol	0.035	5000	5041	28305	n/a	0.50	0.535
Zinc Dialkyldithiophosphate	0.000	0	0	0	n/a	0.50	0.500

Cargo with the highest pressure drop is:

Pentane (iso-)	Max ΔP =	0.65 psi	<	3.00 psi	OK
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Notes: 1) Vapor flow rate used in discharge condition is liquid discharge rate, per USCG guidance 7/15/01

2) Air equivalent flow rate derived from maximum liquid discharge rate and a density correction factor for conservatism (see list of allowable cargoes for details)

3) See ERL flow curve "080M077B"

Pressure Drop through VCS - From #1 Cargo Tank to Shore Connection (per 46 CFR 39.30-1(d)(3) and ABS SBR 5-2-3/7.5.2(c))

Pipe sizes, nominal: 8 in
Pipe ID: 7.981 in
Pipe Flow Area: 50.03 in²
Vapor Dynamic Viscosity: 0.019 centipoise (estimated, based on air @ 115F, Crane 410, Table A-5)

PIPE LENGTH

Length (ft): 221.94 ft 8" pipe
Length (ft): 50.00 ft 6" hose
f, friction factor (pipe): Varies with Reynold's Number (see table below)

VALVE & FITTING EQUIVALENT LENGTH

Equivalent Length (ft): 285.74 ft
f_v, friction factor, turbulent flow (fittings): 0.014 constant, for each pipe size

Shore Connection Pressure Drop (at 25% of Maximum Liquid Loading Rate): 1250 BBL/hr

Cargo	Vapor-Air Mix. Density (lb/ft ³)	Vapor Flow Rate		Reynold's Number		Friction Factor		Vapor Velocity		Head Loss			Component ΔP				ΔP
		BBL/hr	ft ³ /s	6" Hose	8" Pipe	6" Hose	8" Pipe	6" Hose	8" Pipe	6" Hose	8" Pipe	8" Fittings	6" Hose	8" Pipe	8" Fittings	TOTAL	
1	0.123	1563	2.44	59153	44952	0.0212	0.0221	12.1	7.0	4.82	5.64	4.60	0.0041	0.0048	0.0039	0.0129	
2	0.085	1563	2.44	40827	31025	0.0228	0.0233	12.1	7.0	5.16	5.94	4.60	0.0030	0.0035	0.0027	0.0093	
19	0.082	1563	2.44	39166	29763	0.0230	0.0235	12.1	7.0	5.21	6.00	4.60	0.0029	0.0034	0.0026	0.0089	
20	0.079	1563	2.44	37955	28843	0.0231	0.0237	12.1	7.0	5.24	6.04	4.60	0.0029	0.0033	0.0025	0.0087	
21	0.079	1563	2.44	37955	28843	0.0231	0.0237	12.1	7.0	5.24	6.04	4.60	0.0029	0.0033	0.0025	0.0087	
23	0.079	1563	2.44	37955	28843	0.0231	0.0237	12.1	7.0	5.24	6.04	4.60	0.0029	0.0033	0.0025	0.0087	
24	0.079	1563	2.44	37955	28843	0.0231	0.0237	12.1	7.0	5.24	6.04	4.60	0.0029	0.0033	0.0025	0.0087	
26	0.079	1563	2.44	37955	28843	0.0231	0.0237	12.1	7.0	5.24	6.04	4.60	0.0029	0.0033	0.0025	0.0087	
34	0.077	1563	2.44	37189	28261	0.0232	0.0238	12.1	7.0	5.26	6.07	4.60	0.0028	0.0033	0.0025	0.0086	
40	0.085	1563	2.44	40637	30881	0.0228	0.0233	12.1	7.0	5.17	5.95	4.60	0.0030	0.0035	0.0027	0.0092	
42	0.097	1563	2.44	46734	35514	0.0222	0.0226	12.1	7.0	5.03	5.76	4.60	0.0034	0.0039	0.0031	0.0104	
44	0.083	1563	2.44	39824	30264	0.0229	0.0234	12.1	7.0	5.19	5.98	4.60	0.0030	0.0034	0.0026	0.0091	
46	0.086	1563	2.44	41269	31362	0.0227	0.0232	12.1	7.0	5.15	5.93	4.60	0.0031	0.0035	0.0027	0.0094	
47	0.097	1563	2.44	46689	35480	0.0222	0.0226	12.1	7.0	5.03	5.76	4.60	0.0034	0.0039	0.0031	0.0104	
48	0.077	1563	2.44	36794	27961	0.0233	0.0239	12.1	7.0	5.27	6.09	4.60	0.0028	0.0032	0.0024	0.0085	
58	0.078	1563	2.44	37501	28498	0.0232	0.0238	12.1	7.0	5.25	6.06	4.60	0.0028	0.0033	0.0025	0.0086	
64	0.077	1563	2.44	36900	28042	0.0232	0.0239	12.1	7.0	5.27	6.08	4.60	0.0028	0.0032	0.0025	0.0085	
70	0.085	1563	2.44	40908	31087	0.0228	0.0233	12.1	7.0	5.16	5.94	4.60	0.0031	0.0035	0.0027	0.0093	
72	0.116	1563	2.44	55879	42464	0.0215	0.0217	12.1	7.0	4.87	5.53	4.60	0.0039	0.0045	0.0037	0.0121	
73	0.078	1563	2.44	37403	28423	0.0232	0.0238	12.1	7.0	5.25	6.07	4.60	0.0028	0.0033	0.0025	0.0086	
74	0.080	1563	2.44	38577	29316	0.0230	0.0236	12.1	7.0	5.22	6.02	4.60	0.0029	0.0034	0.0026	0.0088	
76	0.078	1563	2.44	37472	28476	0.0232	0.0238	12.1	7.0	5.25	6.06	4.60	0.0028	0.0033	0.0025	0.0086	
77	0.078	1563	2.44	37422	28438	0.0232	0.0238	12.1	7.0	5.25	6.06	4.60	0.0028	0.0033	0.0025	0.0086	
78	0.076	1563	2.44	36663	27861	0.0233	0.0239	12.1	7.0	5.28	6.09	4.60	0.0028	0.0032	0.0024	0.0085	
79	0.076	1563	2.44	36573	27793	0.0233	0.0239	12.1	7.0	5.28	6.10	4.60	0.0028	0.0032	0.0024	0.0084	
81	0.078	1563	2.44	37602	28575	0.0232	0.0238	12.1	7.0	5.25	6.06	4.60	0.0029	0.0033	0.0025	0.0086	
82	0.076	1563	2.44	36670	27866	0.0233	0.0239	12.1	7.0	5.28	6.09	4.60	0.0028	0.0032	0.0024	0.0085	
83	0.076	1563	2.44	36670	27866	0.0233	0.0239	12.1	7.0	5.28	6.09	4.60	0.0028	0.0032	0.0024	0.0085	
84	0.076	1563	2.44	36670	27866	0.0233	0.0239	12.1	7.0	5.28	6.09	4.60	0.0028	0.0032	0.0024	0.0085	
85	0.076	1563	2.44	36720	27905	0.0233	0.0239	12.1	7.0	5.27	6.09	4.60	0.0028	0.0032	0.0024	0.0085	
87	0.078	1563	2.44	37250	28307	0.0232	0.0238	12.1	7.0	5.26	6.07	4.60	0.0028	0.0033	0.0025	0.0086	
91	0.076	1563	2.44	36573	27793	0.0233	0.0239	12.1	7.0	5.28	6.10	4.60	0.0028	0.0032	0.0024	0.0084	
92	0.080	1563	2.44	38577	29316	0.0230	0.0236	12.1	7.0	5.22	6.02	4.60	0.0029	0.0034	0.0026	0.0088	
93	0.077	1563	2.44	37227	28290	0.0232	0.0238	12.1	7.0	5.26	6.07	4.60	0.0028	0.0033	0.0025	0.0086	
94	0.076	1563	2.44	36633	27838	0.0233	0.0239	12.1	7.0	5.28	6.10	4.60	0.0028	0.0032	0.0024	0.0085	
95	0.076	1563	2.44	36674	27870	0.0233	0.0239	12.1	7.0	5.28	6.09	4.60	0.0028	0.0032	0.0024	0.0085	
100	0.076	1563	2.44	36736	27917	0.0233	0.0239	12.1	7.0	5.27	6.09	4.60	0.0028	0.0032	0.0024	0.0085	
101	0.077	1563	2.44	36785	27954	0.0233	0.0239	12.1	7.0	5.27	6.09	4.60	0.0028	0.0032	0.0024	0.0085	
111	0.078	1563	2.44	37379	28406	0.0232	0.0238	12.1	7.0	5.26	6.07	4.60	0.0028	0.0033	0.0025	0.0086	
112	0.103	1563	2.44	49488	37608	0.0220	0.0223	12.1	7.0	4.98	5.68	4.60	0.0036	0.0041	0.0033	0.0109	
113	0.079	1563	2.44	37982	28863	0.0231	0.0237	12.1	7.0	5.24	6.04	4.60	0.0029	0.0033	0.0025	0.0087	
119	0.077	1563	2.44	36884	28029	0.0232	0.0239	12.1	7.0	5.27	6.09	4.60	0.0028	0.0032	0.0025	0.0085	
124	0.076	1563	2.44	36573	27793	0.0233	0.0239	12.1	7.0	5.28	6.10	4.60	0.0028	0.0032	0.0024	0.0084	
128	0.077	1563	2.44	36875	28023	0.0232	0.0239	12.1	7.0	5.27	6.09	4.60	0.0028	0.0032	0.0024	0.0085	
130	0.076	1563	2.44	36573	27793	0.0233	0.0239	12.1	7.0	5.28	6.10	4.60	0.0028	0.0032	0.0024	0.0084	
131	0.078	1563	2.44	37453	28462	0.0232	0.0238	12.1	7.0	5.25	6.06	4.60	0.0028	0.0033	0.0025	0.0086	
132	0.076	1563	2.44	36670	27867	0.0233	0.0239	12.1	7.0	5.28	6.09	4.60	0.0028	0.0032	0.0024	0.0085	
133	0.076	1563	2.44	36682	27876	0.0233	0.0239	12.1	7.0	5.28	6.09	4.60	0.0028	0.0032	0.0024	0.0085	

546	0.083	1563	2.44		39636	30121		0.0229	0.0235		12.1	7.0				5.19	5.98	4.60				0.0030	0.0034	0.0026	0.0090
547	0.083	1563	2.44		39636	30121		0.0229	0.0235		12.1	7.0				5.19	5.98	4.60				0.0030	0.0034	0.0026	0.0090
548	0.081	1563	2.44		38975	29618		0.0230	0.0236		12.1	7.0				5.21	6.01	4.60				0.0029	0.0034	0.0026	0.0089
549	0.083	1563	2.44		39636	30121		0.0229	0.0235		12.1	7.0				5.19	5.98	4.60				0.0030	0.0034	0.0026	0.0090
550	0.077	1563	2.44		37173	28249		0.0232	0.0238		12.1	7.0				5.26	6.07	4.60				0.0028	0.0033	0.0025	0.0086

P-V valve pressure setting: 1.5 psi
80% of P-V valve setting: 1.2 psi

Maximum pressure drop to shore connection: 0.047 psi

MAX ΔP: 0.0470

TOTAL PRESSURE DROP TO SHORE CONNECTION: 0.047 psi OK

Max. allowable back pressure at facility: 1.153 psi

546	0.083	3125	4.87		79272	60241		0.0202	0.0201		24.3	14.0				18.32	20.48	18.38				0.0105	0.0117	0.0105	0.0328
547	0.083	3125	4.87		79272	60241		0.0202	0.0201		24.3	14.0				18.32	20.48	18.38				0.0105	0.0117	0.0105	0.0328
548	0.081	3125	4.87		77950	59237		0.0203	0.0202		24.3	14.0				18.37	20.55	18.38				0.0104	0.0116	0.0104	0.0323
549	0.083	3125	4.87		79272	60241		0.0202	0.0201		24.3	14.0				18.32	20.48	18.38				0.0105	0.0117	0.0105	0.0328
550	0.077	1563	2.44		37173	28249		0.0232	0.0238		12.1	7.0				5.26	6.07	4.60				0.0028	0.0033	0.0025	0.0086
																							MAX ΔP:		0.1770

P-V valve pressure setting: 1.5 psi
80% of P-V valve setting: 1.2 psi

Maximum pressure drop to shore connection: 0.177 psi

TOTAL PRESSURE DROP TO SHORE CONNECTION: 0.177 psi OK

Max. allowable back pressure at facility: 1.023 psi

546	0.083	4688	7.31		118908	90362		0.0190	0.0185		36.4	21.0				38.75	42.35	41.36				0.0222	0.0243	0.0237	0.0702	
547	0.083	4688	7.31		118908	90362		0.0190	0.0185		36.4	21.0				38.75	42.35	41.36				0.0222	0.0243	0.0237	0.0702	
548	0.081	4688	7.31		116926	88855		0.0190	0.0185		36.4	21.0				38.84	42.49	41.36				0.0219	0.0239	0.0233	0.0691	
549	0.083	4688	7.31		118908	90362		0.0190	0.0185		36.4	21.0				38.75	42.35	41.36				0.0222	0.0243	0.0237	0.0702	
550	0.077	4688	7.31		111520	84747		0.0192	0.0187		36.4	21.0				39.11	42.90	41.36				0.0210	0.0231	0.0222	0.0663	
																							MAX ΔP:		0.3871	

P-V valve pressure setting: 1.5 psi
80% of P-V valve setting: 1.2 psi

Maximum pressure drop to shore connection: 0.387 psi

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TOTAL PRESSURE DROP TO SHORE CONNECTION: 0.387 psi OK

Max. allowable back pressure at facility: 0.813 psi

546	0.083	6250	9.75		158544	120482		0.0183	0.0174		48.6	28.1				66.27	71.11	73.54				0.0380	0.0407	0.0421	0.1208
547	0.083	6250	9.75		158544	120482		0.0183	0.0174		48.6	28.1				66.27	71.11	73.54				0.0380	0.0407	0.0421	0.1208
548	0.081	6250	9.75		155901	118474		0.0183	0.0175		48.6	28.1				66.41	71.34	73.54				0.0374	0.0402	0.0414	0.1190
549	0.083	6250	9.75		158544	120482		0.0183	0.0174		48.6	28.1				66.27	71.11	73.54				0.0380	0.0407	0.0421	0.1208
550	0.077	6250	9.75		148693	112997		0.0184	0.0176		48.6	28.1				66.82	72.01	73.54				0.0359	0.0387	0.0395	0.1141
MAX ΔP:																									0.6763

P-V valve pressure setting: 1.5 psi
80% of P-V valve setting: 1.2 psi

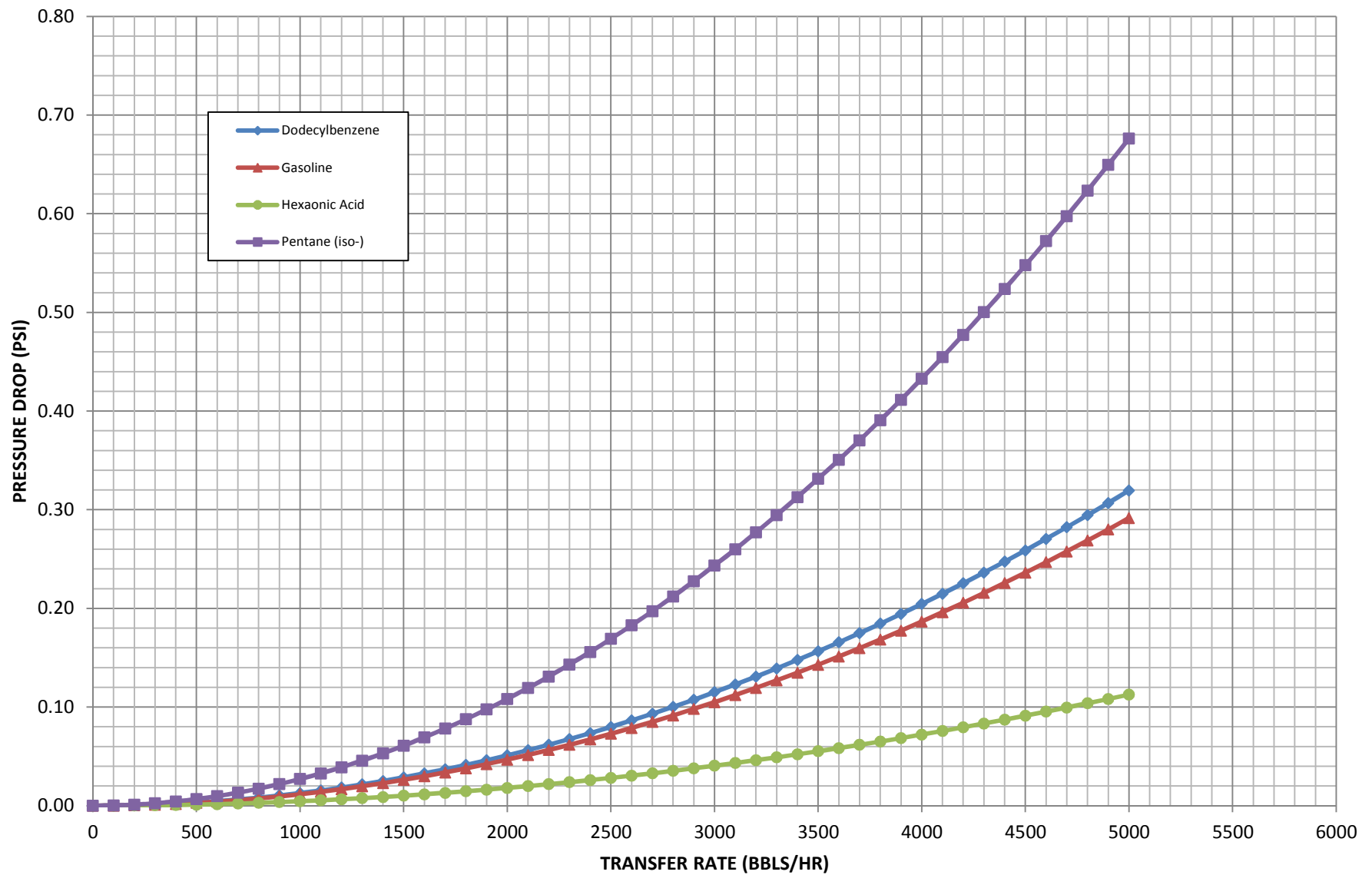
Maximum pressure drop to shore connection: 0.676 psi

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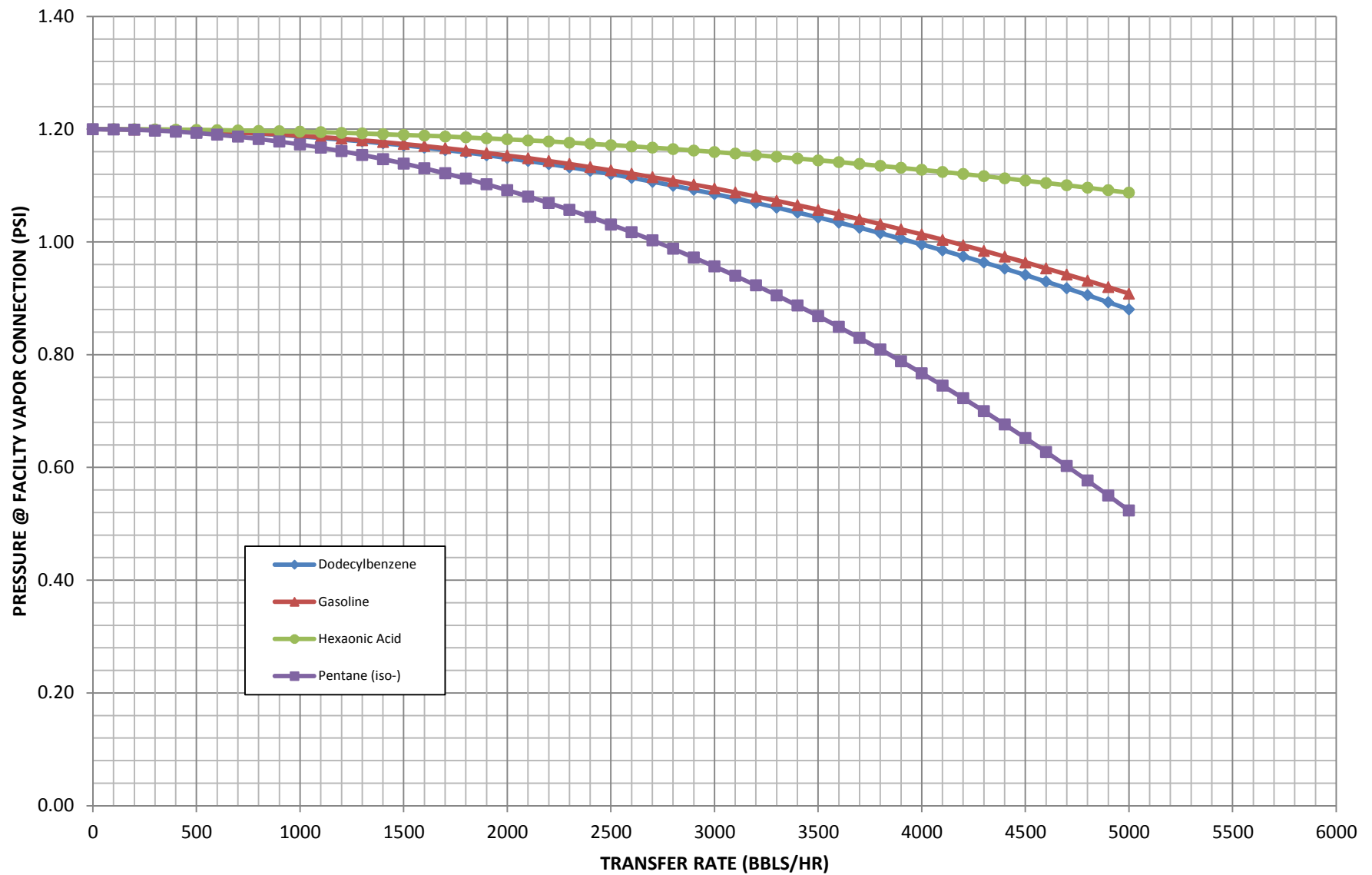
TOTAL PRESSURE DROP TO SHORE CONNECTION: 0.676 psi OK

Max. allowable back pressure at facility: 0.524 psi

LIQUID TRANSFER RATE vs PRESSURE DROP (FOR SUBCHAPTER "D" CARGOES)



LIQUID TRANSFER RATE vs PRESSURE DROP (FOR SUBCHAPTER "D" CARGOES)



546	0.083	1250	1.95		31709	24096		0.0240	0.0247		9.7	5.6				3.48	4.04	2.94				0.0020	0.0023	0.0017	0.0060
547	0.083	1250	1.95		31709	24096		0.0240	0.0247		9.7	5.6				3.48	4.04	2.94				0.0020	0.0023	0.0017	0.0060
548	0.081	1250	1.95		31180	23695		0.0241	0.0248		9.7	5.6				3.49	4.06	2.94				0.0020	0.0023	0.0017	0.0059
549	0.083	1250	1.95		31709	24096		0.0240	0.0247		9.7	5.6				3.48	4.04	2.94				0.0020	0.0023	0.0017	0.0060
550	0.077	1250	1.95		29739	22599		0.0243	0.0251		9.7	5.6				3.53	4.10	2.94				0.0019	0.0022	0.0016	0.0057
																							MAX ΔP:		0.0207

P-V valve vacuum setting: 0.5 psi
80% of P-V valve setting: 0.4 psi

Maximum pressure drop to shore connection: 0.021 psi

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TOTAL PRESSURE DROP TO SHORE CONNECTION: 0.021 psi OK

Max. allowable back pressure at facility: 0.379 psi

546	0.083	2500	3.90		63417	48193		0.0210	0.0211		19.4	11.2				12.18	13.76	11.77				0.0070	0.0079	0.0067	0.0216
547	0.083	2500	3.90		63417	48193		0.0210	0.0211		19.4	11.2				12.18	13.76	11.77				0.0070	0.0079	0.0067	0.0216
548	0.081	2500	3.90		62360	47389		0.0210	0.0212		19.4	11.2				12.21	13.81	11.77				0.0069	0.0078	0.0066	0.0213
549	0.083	2500	3.90		63417	48193		0.0210	0.0211		19.4	11.2				12.18	13.76	11.77				0.0070	0.0079	0.0067	0.0216
550	0.077	2500	3.90		59477	45199		0.0212	0.0214		19.4	11.2				12.32	13.96	11.77				0.0066	0.0075	0.0063	0.0204
																							MAX ΔP:		0.0773

P-V valve vacuum setting: 0.5 psi
80% of P-V valve setting: 0.4 psi

Maximum pressure drop to shore connection: 0.077 psi

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TOTAL PRESSURE DROP TO SHORE CONNECTION: 0.077 psi OK

Max. allowable back pressure at facility: 0.323 psi

546	0.083	3750	5.85		95126	72289		0.0196	0.0193		29.2	16.8				25.63	28.38	26.47				0.0147	0.0163	0.0152	0.0461
547	0.083	3750	5.85		95126	72289		0.0196	0.0193		29.2	16.8				25.63	28.38	26.47				0.0147	0.0163	0.0152	0.0461
548	0.081	3750	5.85		93541	71084		0.0197	0.0194		29.2	16.8				25.70	28.48	26.47				0.0145	0.0160	0.0149	0.0454
549	0.083	3750	5.85		95126	72289		0.0196	0.0193		29.2	16.8				25.63	28.38	26.47				0.0147	0.0163	0.0152	0.0461
550	0.077	3750	5.85		89216	67798		0.0198	0.0196		29.2	16.8				25.89	28.76	26.47				0.0139	0.0155	0.0142	0.0436
																							MAX ΔP:		0.1682

P-V valve vacuum setting: 0.5 psi
80% of P-V valve setting: 0.4 psi

Maximum pressure drop to shore connection: 0.168 psi

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TOTAL PRESSURE DROP TO SHORE CONNECTION: 0.168 psi OK

Max. allowable back pressure at facility: 0.232 psi

546	0.083	5000	7.80		126835	96386		0.0188	0.0182		38.9	22.4				43.69	47.56	47.06				0.0250	0.0272	0.0270	0.0792
547	0.083	5000	7.80		126835	96386		0.0188	0.0182		38.9	22.4				43.69	47.56	47.06				0.0250	0.0272	0.0270	0.0792
548	0.081	5000	7.80		124721	94779		0.0189	0.0183		38.9	22.4				43.79	47.72	47.06				0.0247	0.0269	0.0265	0.0781
549	0.083	5000	7.80		126835	96386		0.0188	0.0182		38.9	22.4				43.69	47.56	47.06				0.0250	0.0272	0.0270	0.0792
550	0.077	5000	7.80		118955	90397		0.0190	0.0185		38.9	22.4				44.08	48.18	47.06				0.0237	0.0259	0.0253	0.0749
																							MAX ΔP:		0.2929

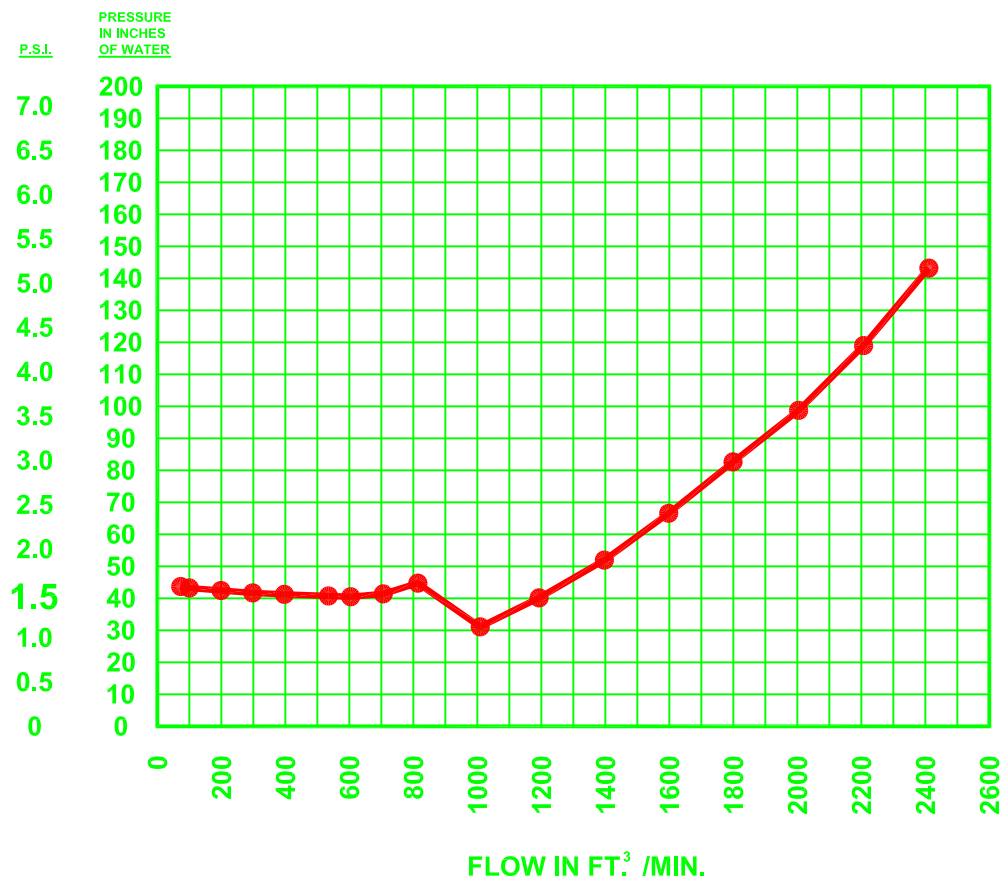
P-V valve vacuum setting: 0.5 psi
80% of P-V valve setting: 0.4 psi

Maximum pressure drop to shore connection: 0.293 psi

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TOTAL PRESSURE DROP TO SHORE CONNECTION: 0.293 psi OK

Max. allowable back pressure at facility: 0.107 psi



Curve for PRESSURE side of 6" PV Valve - 1.5 PSI

CEESI - Colorado Engineering

data based on air flow

Barrels Per Hour	Flow FT. ³ per Min.	Pressure In. of H2O
------------------------	--------------------------------------	---------------------------

781	73	43.70
1070	100	43.23
2129	199	42.46
3189	298	41.71
4248	397	41.24
5725	535	40.76
6463	604	40.51
7554	706	41.40
8710	814	44.76
10796	1009	31.09
12765	1193	40.15
14948	1397	51.94
17099	1598	66.58
19249	1799	82.64
21443	2004	98.75
23615	2207	118.99
25798	2411	143.23



**ELECTROMECHANICAL
RESEARCH LABORATORIES, INC.**

P.O. 1026 NEW ALBANY, IN 47150

DATE
6/30/09

TOLERANCES
.0= +/- .030
.00= +/- .015
.000= +/- .005

DRAWN
D. URBAN

APPROVED

SCALE

JOB NO.

PART NAME
Flow Curve 1.5 PSI Pressure

UNIT NAME
6" PV Valve MDII

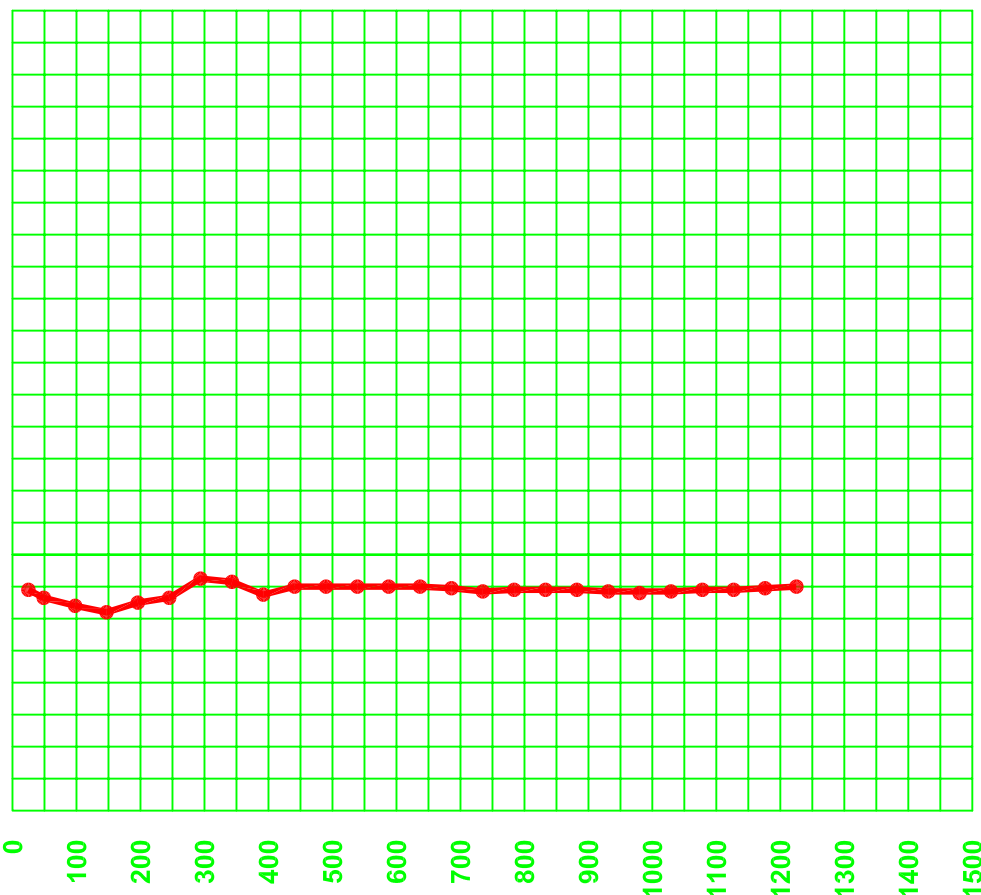
DRAWING NO.
180U172B

ITEM NO.

P.S.I.
**PRESSURE
IN INCHES
OF WATER**

1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0

50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0



FLOW IN FT.³ / MIN.

CURVE FOR VACUUM SIDE OF 6" PV VALVE - 0.5 PSI

DATA BASED ON AIR FLOW

BARRELS PER HOUR	FLOW FT.³ / MIN.	PRESSURE IN. OF H₂O
262	25	13.8
524	49	13.3
1048	98	12.8
1571	147	12.4
2095	196	13.0
2619	245	13.3
3143	294	14.5
3667	343	14.3
4190	392	13.5
4714	441	14.0
5238	490	14.0
5762	539	14.0
6286	588	14.0
6810	637	14.0
7333	686	13.9
7857	735	13.7
8381	784	13.8
8905	833	13.8
9429	882	13.8
9953	931	13.7
11001	980	13.6
11525	1029	13.7
12049	1078	13.8
12573	1127	13.8
13097	1176	13.9
13621	1225	14.0



**ELECTROMECHANICAL
RESEARCH LABORATORIES, INC.**

P.O. 1026 NEW ALBANY, IN 47150

DATE
3/21/01

TOLERANCES
.0= +/- .030
.00= +/- .015
.000= +/- .005

DRAWN
D. URBAN

APPROVED

SCALE

JOB NO.

PART NAME
Flow Curve 0.5 PSI Vacuum

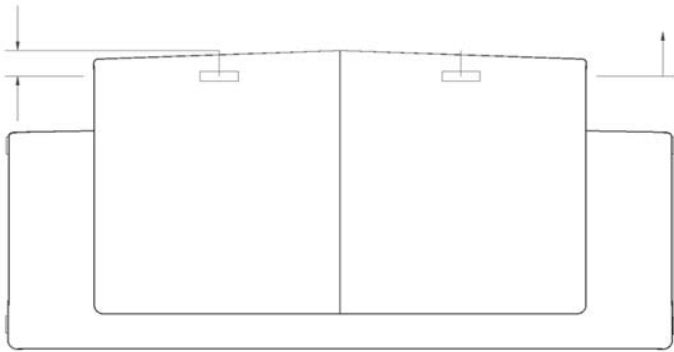
UNIT NAME
Marine 6" PV (MD II)

DRAWING NO.
080M077B

ITEM NO.

High Level and Overfill Alarm Calculations

Recommended High Level Set
Point = 20.625 inches (below
top of tank at Centerline)
(95% tank level)



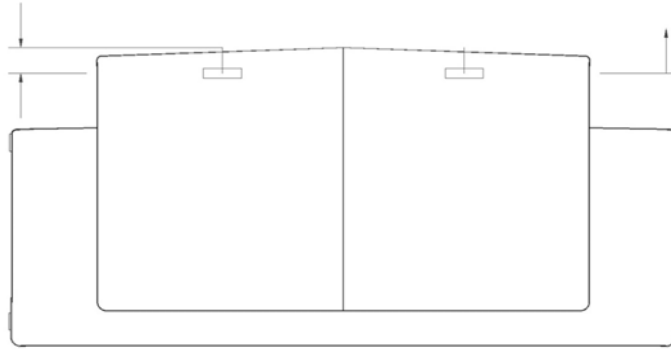
Volume Above High
Level Set Point =
836 ft³

Maximum Cargo Loading Rate (per Tank) = 2500 BBL/hr
= 234.0 ft³/min

Camber Height =	0.50 ft	
Trunk Width =	23.50 ft	
Trunk Length =	53.33 ft	Tank #3 P/S
the Least High Level Set Point =	0.917 ft	
=	11.00 in	rounded-up

Total Tank Volume =	16607 ft ³
Actual Volume Above High Level Indicator Set Point =	836 ft ³
Percentage of Tank Vol Above High Level Set Point =	5%
Percentage of Tank Vol Below High Level Set Point =	95%

Recommended Overfill Alarm Level
Set Point = 3.75 inches
(Below top of tank at Centerline)
(98% tank level)



Volume Above Overfill
Level Set Point =
235 ft³

Maximum Cargo Loading Rate (per Tank) = 2500 BBL/hr
= 234.0 ft³/min

Camber Height = 0.50 ft
Trunk Width = 23.50 ft
Trunk Length = 53.33 ft
the Least High Level Set Point = 0.435 ft
= 5.25 in

Tank #3 P/S
rounded-up

Minimum Allowable Time From Alarm to Overflow = 1.00 min
Actual Time From Alarm to Overflow = 1.00 min

Total Tank Volume = 16607 ft³
Actual Volume Above High Level Indicator Set Point = 235 ft³
Percentage of Tank Vol Above High Level Set Point = 1%
Percentage of Tank Vol Below High Level Set Point = 99%