

**VAPOR COLLECTION SYSTEM CALCULATIONS**

**FOR**

**BARGE NAME(s): "CBC 1335" thru "CBC 1359"**

**SOUTHWEST SHIPYARD HULL(s): 9628 thru 9652**

**200'-0" X 35'-0" X 12'-6" DOUBLE SKIN TANK BARGE (O/D)**

**CANAL BARGE COMPANY, INC.**

**May 17, 2011**

**Prepared by:**

A handwritten signature in black ink, appearing to read "K. Kumaria", written over the printed name "Chetan Kumaria, PE, MBA".

**Chetan Kumaria, PE, MBA  
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# MARINE SOLUTIONS, INC.

Rev. 0 dated May 16, 2011

## VCS SYSTEM INFORMATION:

### 1. GENERAL DESCRIPTION OF VESSEL:

A. NAME (S): CBC 1335 THRU CBC 1359  
B. USCG PROJECT NUMBER: P016344  
C. DIMENSIONS: 200'-0" X 35'-0" X 12'-6"  
D. SERVICE: TANK BARGE (O/D)  
E. MAX. DESIGN WORKING PRESSURE: 3.5 PSIG  
F. PV VALVE PRESSURE SETTING: 1 PSIG  
G. PV VALVE VACUUM SETTING: 0.5 PSIG  
H. MAX. DISCHARGE RATE: 800 BBL/HR

### 2. VAPOR CONTROL SYSTEM

A. PIPE DIAMETER: 7.981 INCHES IPS  
B. PIPE LENGTHS: A- 1'-7 1/4" B-3'-5 7/8" C-53'-2 23/64" D-42'-3 43/64", E-48'-9 15/16"  
F- 4'-1 1/4" G-1'-6 1/8" H-8'-0 3/4"

### C. PV VALVE VENTING CAPACITY:

(1) 6" BERGAN KLPH, SET @ 1.0 PSI  
(2) MAX. CAPACITY: 21666 BBL/HR OF AIR  
(3) 0.5 PSIG VAC.

D. SPILL VALVE RELIEVING CAPACITY: NON INSTALLED

E. MAX. VAPOR-AIR MIXTURE DENSITY: 0.335 LBM/FT<sup>3</sup> FOR SUB D  
0.213 LBM/FT<sup>3</sup> FOR SUB O

F. MAX. LIQUID LOADING RATE: 3500 BBL/HR

G. DARCY FRICTION FACTOR: 0.014

H. VCS CARGOES: SEE TABLE 1 & TABLE 4

### I. ADDITIONAL MIS. INFORMATION:

SYSTEM IS DESIGNED TO ACCOMMODATE INTERNAL VISUAL INSPECTION.

## VCS CALCULATIONS

### 1. CARGO AUTHORITY::

The vapor collection system installed on this barge is designed to carry the cargoes listed in Table 1, Table 4 and Crude Oil and Gasoline Blends. These Cargoes are to be listed on the barge's Certificate of Inspection.

### 2. DETERMINING VAPOR\_AIR MIXTURE DENSITY AND VAPOR GROWTH RATE:

Pentane (iso-) has the heaviest vapor-air mixture density and the highest vapor growth rate (see Table 1)

### 3. THE MAXIMUM LIQUID TRANSFER RATE AS IMPOSED BY THE CAPACITY OF THE CARGO VENTING SYSTEM:

Tank 3 is the farthest tank from the P/V valve. Using Crane's Technical Paper No. 410, the total equivalent length (L) for the path is shown in Table 2.

TABLE 2

PIPE/FITTINGS	QUANTITY	UNIT EQ. LENGHT (FT)	TOTAL EQ. LENGTH (FT)
Straight Pipe	1	155.51	155.51
Entrance	1	37.05	37.05
T Branch	5	39.91	199.55
8"X6"RED	1	39.88	39.88
T Run Thru	6	13.3	79.8
		Total	511.79

Using Darcy's Equation, with a 0.014 friction factor and the maximum liquid transfer rate, the pressure drop along the VCS piping between the #3 cargo tank and the P/V valve for each cargo is shown in Table 1 & Table 4.

Using a 3500 bbl/h liquid transfer rate, the vapor-air mixture and air-equivalent volumetric flow rate for each cargo are given in Table 1 & Table 4. At a setting of 1.0 psig, the Bergan KLPH-6 PV Valve has an adequate pressure relieving capacity of air for each cargo listed in Table 1 & Table 4. The greatest pressure drop in the venting system (1.228 psig) does not exceed the cargo tank maximum design working pressure of 3.5 psi.

The maximum vacuum that can exist in a tank is 0.512 psig. The barges are constructed as per ABS rules and regulations for a pressure of 3.5 psig and are tested for a pressure of 3.5 psig. Therefore the maximum vacuum of 0.512 psig is within the design capacity of these barges and an unloading rate of 800 bbl/h is acceptable.

**4. THE MAXIMUM LIQUID TRANSFER RATE AS IMPOSED BY THE RELIEVING CAPACITY OF THE CARGO TANK SPILL VALVE.** Non-installed

**5. THE MAXIMUM LIQUID TRANSFER RATE AS IMPOSED BY THE SET POINT OF THE OVERFILL ALARM.**

The #1 cargo tank has a trunk top dimension of 46'-8" x 27'-0". The set point of the overfill alarm is set at 9" below the trunk top at tank centerline. With a liquid transfer rate of 3500 bbl/h, the person in charge of transfer operation has more than 2 minutes to stop the transfer operation before tank overflows. Thus VCS meets 46 CFR 39.20-9.

**6. THE MAXIMUM LIQUID TRANSFER RATE AS IMPOSED BY 46 CFR 39.30-1(d)(3).**

This requires the sum of the pressure drop along the longest path and the pressure at the facility vapor connection not to exceed 80 percent of the P/V valve setting. The total equivalent length from cargo tank 3 to the vapor connection is given in Table 3.

**TABLE 3**

PIPE/FITTINGS	QUANTITY	UNIT EQ. LENGTH (FT)	TOTAL EQ. LENGTH (FT)
Straight Pipe	1	163.73	163.73
Entrance	1	37.05	37.05
T Branch	4	39.91	159.64
T Run	7	13.33	93.31
8" Gate Valve	1	5.32	5.32
		<b>Total</b>	<b>459.05</b>

Pressure drop at the maximum liquid transfer rate of 3500 bbl/h along this path for each cargo is given in Tables 1 & 4. The largest pressure drop does not exceed 80 percent of the P/V valve pressure setting (0.8 psig).

TABLE 1 (SUB CHAPTER "D" CARGOES)

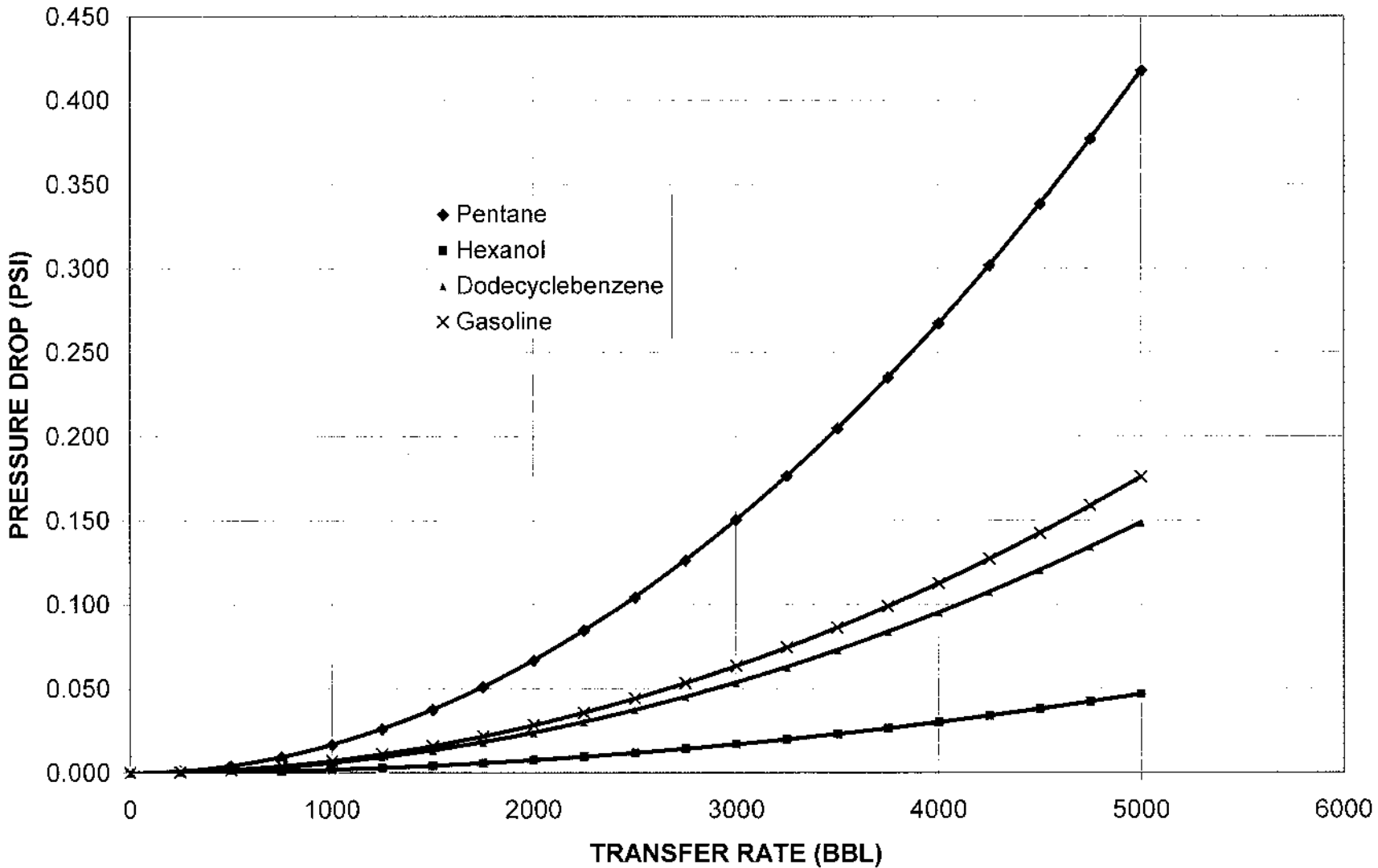
CHRIS CODE	NAME	VCS CAT	LIQ SG	VAPOR PRESS	VAPOR SG	VAPOR		PRESSURE		VAPOR VOLUMETRIC FLOW RATE (bbl/h)	AIR EQUIVALENT FLOW RATE	PRESSURE DROP TO SHORE CONNECTION IN VCS (psig) (LOADING)*	PRESSURE DROP TO PV VALVE IN VCS(psig) (UNLOADING)	PRESSURE DROP TO SHORE CONNECT IN VCS (ps (UNLOADING)
						AIR WEIGHT DENSITY	VAPOR GROWTH RATE	DROP TO PV VALVE IN VCS(psig) (LOADING)	DROP TO PV VALVE IN VCS(psig) (UNLOADING)					
1 ACT	Acetone	1	0.79	10	2	0.121	1.2000	0.050		4200	5372	0.045	0.003	0.002
2 ACP	Acetophenone	1	1.03	0.6	4.14	0.082	1.0120	0.024		3542	3747	0.022	0.001	0.001
19 AAT	Amyl Acetate (iso-)	1	0.88	0.33	4.48	0.079	1.0086	0.023		3523	3649	0.021	0.001	0.001
20 AAI	Amyl Alcohol (iso-, n-, sec-, primary) (See also IAA, 1	1	0.82	0.3	3.04	0.077	1.0060	0.022		3521	3588	0.020	0.001	0.001
21 AAN	Amyl Alcohol (n-)	1	0.82	0.3	3.04	0.077	1.0060	0.022		3521	3588	0.020	0.001	0.001
23 APM	Amyl Alcohol, Primary	1	0.82	0.3	3.04	0.077	1.0060	0.022		3521	3588	0.020	0.001	0.001
24 ASE	Amyl Alcohol, (sec-)	1	0.82	0.3	3.04	0.077	1.0060	0.022		3521	3588	0.020	0.001	0.001
26 IAA	Amyl Alcohol, (iso-)	1	0.82	0.3	3.04	0.077	1.0060	0.022		3521	3588	0.020	0.001	0.001
34 BAL	Benzyl Alcohol	1	1.05	0.1	3.73	0.075	1.0020	0.022		3507	3536	0.019	0.001	0.001
40 BAX	Butyl Acetate (iso-, n-)	1	0.87	0.6	4	0.082	1.0120	0.024		3542	3738	0.022	0.001	0.001
42 BTA	Butyl Acetate (sec-)	1	0.89	1.5	4	0.095	1.0300	0.029		3605	4088	0.026	0.002	0.001
44 IAL	Butyl Alcohol (iso-)	1	0.81	0.9	2.6	0.080	1.0180	0.024		3563	3722	0.021	0.001	0.001
46 BAS	Butyl Alcohol (sec-)	1	0.81	1.3	2.6	0.083	1.0260	0.025		3591	3820	0.023	0.001	0.001
47 BAT	Butyl Alcohol (tert-)	1	0.78	2.8	2.6	0.095	1.0560	0.030		3696	4189	0.027	0.002	0.001
48 BPH	Butyl Benzyl Phthalate	1	1.12	0.01	10.8	0.074	1.0002	0.021		3501	3511	0.019	0.001	0.001
64 CLS	Caprolactam Solutions	1	1.02	0.05	3.9	0.074	1.0010	0.021		3504	3519	0.019	0.001	0.001
70 CUM	Cumene	1	0.86	0.60	4.20	0.083	1.0120	0.024		3542	3751	0.022	0.001	0.001
72 CHX	Cyclohexane	1	0.78	4.5	2.9	0.114	1.0900	0.039		3815	4740	0.035	0.002	0.002
73 CHN	Cyclohexanol	1	0.95	0.15	3.45	0.075	1.0030	0.022		3511	3550	0.020	0.001	0.001
74 CPD	1,3-Cyclopentadiene dimer (molten)	1	0.69	0.25	4.55	0.078	1.0050	0.023		3518	3615	0.020	0.001	0.001
76 CMP	Cymene (para-)	1	0.86	0.11	4.62	0.076	1.0022	0.022		3508	3551	0.020	0.001	0.001
77 DHN	Decahydronaphthalene	1	0.89	0.1	4.76	0.075	1.0020	0.022		3507	3548	0.019	0.001	0.001
78 IDA	Decaldehyde (iso-)	1	0.83	0.01	5	0.074	1.0002	0.021		3501	3504	0.019	0.001	0.001
79 DAL	Decaldehyde (n-)	1	0.83	0	5.01	0.074	1.0000	0.021		3500	3499	0.019	0.001	0.001
81 DCE	Decane	1	0.74	0.12	4.8	0.076	1.0024	0.022		3508	3558	0.020	0.001	0.001
82 DAX	Decyl Alcohol (all isomers) (Decanol)	1	0.83	0.01	5.3	0.074	1.0002	0.021		3501	3505	0.019	0.001	0.001
83 ISA	Decyl Alcohol (iso-)	1	0.83	0.01	5.3	0.074	1.0002	0.021		3501	3505	0.019	0.001	0.001
84 DAN	Decyl Alcohol (n-)	1	0.83	0.01	5.3	0.074	1.0002	0.021		3501	3505	0.019	0.001	0.001
85 DBZ	Decylbenzene (n-)	1	0.86	0.01	7.52	0.074	1.0002	0.021		3501	3507	0.019	0.001	0.001
87 DAA	Diacetone Alcohol	1	0.97	0.1	4	0.075	1.0020	0.022		3507	3539	0.019	0.001	0.001
91 DPA	Dibutyl Phthalate (ortho-)	1	1.05	0	9.59	0.074	1.0000	0.021		3500	3499	0.019	0.001	0.001
92 DPT	Dicyclopentadiene, See 1,3-Cyclopentadiene Dimer; 2	1	0.98	0.25	4.55	0.078	1.0050	0.023		3518	3615	0.020	0.001	0.001
93 DEB	Diethylbenzene	1	0.87	0.08	4.62	0.075	1.0016	0.022		3506	3537	0.019	0.001	0.001
94 DEG	Diethylene Glycol	1	1.12	0.01	3.66	0.074	1.0002	0.021		3501	3503	0.019	0.001	0.001
95 DME	Diethylene Glycol Butyl Ether	1	0.95	0.01	5.5	0.074	1.0002	0.021		3501	3505	0.019	0.001	0.001
100 DGA	Diethylene Glycol Ethyl Ether Acetate	1	0.99	0.02	4.62	0.074	1.0004	0.021		3501	3508	0.019	0.001	0.001
101 DGM	Diethylene Glycol Methyl Ether	1	1.03	0.03	4.14	0.074	1.0006	0.021		3502	3512	0.019	0.001	0.001
111 DBC	Diisobutylcarbinol	1	0.81	0.09	4.97	0.075	1.0018	0.022		3506	3545	0.019	0.001	0.001
112 DBL	Diisobutylene	1	0.72	2	3.86	0.100	1.0400	0.031		3640	4251	0.028	0.002	0.001
113 DIX	Diisobutyl Ketone	1	0.81	0.16	4.9	0.077	1.0032	0.022		3511	3579	0.020	0.001	0.001
119 DIX	Diisopropylbenzene (all isomer)	1	0.86	0.03	5.6	0.074	1.0006	0.021		3502	3516	0.019	0.001	0.001
124 DTL	Dimethyl Phthalate	1	1.19	0	6.69	0.074	1.0000	0.021		3500	3499	0.019	0.001	0.001
130 DOP	Dioctyl Phthalate	1	0.98	0	13.47	0.074	1.0000	0.021		3500	3499	0.019	0.001	0.001
131 DPN	Dipentene	1	0.84	0.1	4.9	0.075	1.0020	0.022		3507	3549	0.019	0.001	0.001
132 DIL	Diphenyl	1	0.99	0.01	5.31	0.074	1.0002	0.021		3501	3505	0.019	0.001	0.001
133 DDO	Diphenyl, Diphenyl Ether Mixture	1	1.07	0.01	5.86	0.074	1.0002	0.021		3501	3505	0.019	0.001	0.001
134 DPE	Diphenyl Ether	1	1.07	0.01	5.87	0.074	1.0002	0.021		3501	3505	0.019	0.001	0.001
136 DPG	Dipropylene Glycol	1	1.03	0.07	4.63	0.075	1.0014	0.022		3505	3532	0.019	0.001	0.001
139 DFF	Distillates: Flashed Feed Stocks	1	0.75	2.3	3.4	0.100	1.0460	0.031		3661	4255	0.028	0.002	0.001
140 DSR	Distillates: Straight Run	1	0.73	2.3	3.4	0.100	1.0460	0.031		3661	4255	0.028	0.002	0.001
145 DOZ	Dodecene (all isomers)	1	0.76	0.02	6.81	0.074	1.0004	0.021		3501	3511	0.019	0.001	0.001
146 DOD	Dodecene	1	0.76	0.02	5.81	0.074	1.0004	0.021		3501	3511	0.019	0.001	0.001
147 DDB	Dodecylbenzene	1	0.86	4.7	8.4	0.237	1.0940	0.081		3829	6864	0.073	0.004	0.004
155 ETG	Ethoxy Triglycol (crude)	1	1.02	0	6.14	0.074	1.0000	0.021		3500	3499	0.019	0.001	0.001
156 ETA	Ethyl Acetate	1	0.9	4.5	3.04	0.117	1.0900	0.040		3815	4801	0.036	0.002	0.002
157 EAA	Ethyl Acetoacetate	1	1.03	0.2	4.48	0.077	1.0040	0.022		3514	3590	0.020	0.001	0.001
158 EAL	Ethyl Alcohol (Ethanol)	1	0.79	3.5	1.6	0.083	1.0700	0.027		3745	3986	0.025	0.001	0.001
160 ETB	Ethyl Benzene	1	0.87	0.6	3.56	0.081	1.0120	0.024		3542	3710	0.021	0.001	0.001
161 EBT	Ethyl Butanol	1	0.83	0.12	3.52	0.075	1.0024	0.022		3508	3541	0.019	0.001	0.001
162 EBR	Ethyl Butyrate	1	0.88	1	4	0.088	1.0200	0.026		3570	3895	0.023	0.001	0.001

163	ECY	Ethyl Cyclohexane	1	0.79	0.5	3.87	0.080	1.0100	0.024	3535	3592	0.021	0.001	0.001
166	EGL	Ethylene Glycol	1	1.19	0.01	2.21	0.074	1.0002	0.021	3501	3501	0.019	0.001	0.001
169	EMA	Ethylene Glycol Butyl Ether Acetate	1	0.94	0.05	5.52	0.075	1.0010	0.021	3504	3528	0.019	0.001	0.001
172	EGY	Ethylene Glycol Diacetate	1	1.1	0.01	5.03	0.074	1.0002	0.021	3501	3504	0.019	0.001	0.001
178	EME	Ethylene Glycol Methyl Ether	1	1.1	0.01	4.8	0.074	1.0002	0.021	3501	3504	0.019	0.001	0.001
180	EPE	Ethylene Glycol Phenyl Ether	1	1.1	0.01	4.8	0.074	1.0002	0.021	3501	3504	0.019	0.001	0.001
184	EHA	2-Ethylhexaldehyde, See Octyl Aldehydes	1	0.82	0.17	4.41	0.076	1.0034	0.022	3512	3575	0.020	0.001	0.001
186	EHX	2-Ethylhexanol, see Octanol (all isomers)	1	0.84	0.02	4.5	0.074	1.0004	0.021	3501	3508	0.019	0.001	0.001
190	EPR	Ethyl Propionate	1	0.89	3.5	1.6	0.063	1.0700	0.027	3745	3986	0.025	0.001	0.001
191	ETE	Ethyl Toluene	1	0.88	0.28	4.15	0.078	1.0056	0.023	3520	3616	0.020	0.001	0.001
194	FAM	Formamide	1	1.13	0.1	1.55	0.074	1.0020	0.021	3507	3512	0.019	0.001	0.001
195	FAL	Furfuryl Alcohol	1	1.13	0.05	3.4	0.074	1.0010	0.021	3504	3516	0.019	0.001	0.001
197	GAK	Gasoline Blended Stocks: Alkylates	1	0.75	12.5	3.4	0.214	1.2500	0.096	4375	7462	0.086	0.005	0.005
198	GRF	Gasoline Blended Stocks: Reformate	1	0.8	12.5	3.4	0.214	1.2500	0.096	4375	7462	0.086	0.005	0.005
199	GAT	Gasolines: Automotive (containing not over 4.23 grs 1	1	0.74	12.5	3.4	0.214	1.2500	0.096	4375	7462	0.086	0.005	0.005
200	GAV	Gasolines: Aviation (containing not over 4.86 grams 1	1	0.71	12.5	3.4	0.214	1.2500	0.096	4375	7462	0.086	0.005	0.005
201	GCS	Gasolines: Casingshead	1	0.67	12.5	3.4	0.214	1.2500	0.096	4375	7462	0.086	0.005	0.005
202	GPL	Gasolines: Polymer	1	0.75	12.5	3.4	0.214	1.2500	0.096	4375	7462	0.086	0.005	0.005
203	GSR	Gasolines: Straight Run	1	0.75	12.5	3.4	0.214	1.2500	0.096	4375	7462	0.086	0.005	0.005
204	GCR	Glycerine	1	1.26	0	3.17	0.074	1.0000	0.021	3500	3499	0.019	0.001	0.001
217	HMX	Heptane (all isomers) (Methylhexane)	1	0.68	2.5	3.45	0.102	1.0500	0.032	3675	4332	0.029	0.002	0.002
218	HPT	Heptane (n-)	1	0.68	2.5	3.45	0.102	1.0500	0.032	3675	4332	0.029	0.002	0.002
220	HTX	Heptanol (all isomers)	1	0.82	0.04	4	0.074	1.0008	0.021	3503	3515	0.019	0.001	0.001
221	HTN	Heptanol (all isomers)	1	0.82	0.04	4	0.074	1.0008	0.021	3503	3515	0.019	0.001	0.001
222	HPX	Heptene (all isomers)	2	0.7	2.9	3.4	0.106	1.0580	0.034	3703	4447	0.031	0.002	0.002
223	THE	Heptene (1-)	1	0.7	2.8	3.4	0.105	1.0560	0.034	3696	4415	0.030	0.002	0.002
229	HXS	Hexane (all isomers)	1	0.66	7	3	0.139	1.1400	0.052	3990	5486	0.047	0.003	0.003
230	HXA	Hexane	1	0.66	7	3	0.139	1.1400	0.052	3990	5486	0.047	0.003	0.003
231	HXO	Hexanoic Acid	1	0.93	0.01	4	0.074	1.0002	0.021	3501	3503	0.019	0.001	0.001
232	HXN	Hexanol	1	0.82	1	3.52	0.085	1.0200	0.025	3570	3845	0.023	0.001	0.001
234	HEX	Hexene (all isomers)	2	0.67	8	2.9	0.145	1.1600	0.056	4060	5694	0.050	0.003	0.003
235	HXE	Hexene (1-)	1	0.67	8.2	2.9	0.147	1.1640	0.057	4074	5749	0.051	0.003	0.003
236	HXT	Hexene (2-)	1	0.67	8.2	2.9	0.147	1.1640	0.057	4074	5749	0.051	0.003	0.003
238	HXG	Hexylene Glycol	4	0.92	0.01	1.1	0.074	1.0002	0.021	3501	3500	0.019	0.001	0.001
243	IPH	Isophorone	1	0.93	0.01	4.75	0.074	1.0002	0.021	3501	3504	0.019	0.001	0.001
244	JPO	Jet Fuels: JP-1 (Kerosene)	1	0.8	0.14	4.5	0.076	1.0028	0.022	3510	3563	0.020	0.001	0.001
245	JPT	Jet Fuels: JP-3	1	0.8	8.51	4.5	0.213	1.1702	0.084	4096	6969	0.075	0.004	0.004
246	JPF	Jet Fuels: JP-4	1	0.81	3.4	4	0.121	1.0680	0.040	3738	4800	0.036	0.002	0.002
247	JPV	Jet Fuels: JP-5 (Kerosene, heavy)	1	0.82	0.1	4	0.075	1.0020	0.022	3507	3539	0.019	0.001	0.001
249	KRS	Kerosene	1	0.81	0.15	4.5	0.078	1.0030	0.022	3511	3568	0.020	0.001	0.001
263	MTT	Methyl Acetate	1	0.92	6.1	2.6	0.119	1.1220	0.043	3927	4999	0.039	0.002	0.002
265	MAL	Methyl Alcohol (See Methanol)	1	0.79	6.63	1.1	0.077	1.1326	0.028	3964	4046	0.026	0.001	0.001
266	MAC	Methyl Amyl Acetate	1	0.86	0.33	4.97	0.080	1.0066	0.023	3523	3666	0.021	0.001	0.001
267	MAA	Methyl Amyl Alcohol	1	0.81	0.43	3.52	0.079	1.0086	0.023	3530	3649	0.021	0.001	0.001
271	MBK	Methyl n-Butyl Ketone	1	0.81	0.97	3.5	0.085	1.0194	0.025	3568	3832	0.023	0.001	0.001
273	MBU	Methyl Butyrate	1	0.9	1.26	3.53	0.089	1.0252	0.027	3588	3935	0.024	0.001	0.001
274	MEK	Methyl Ethyl Ketone	1	0.8	4.5	2.5	0.105	1.0900	0.036	3815	4561	0.032	0.002	0.002
275	MTF	Methyl Formal (Dimethyl Formal)	1	0.86	15.42	2.8	0.189	1.3084	0.093	4579	7341	0.093	0.005	0.004
276	MHK	Methyl Heptyl Ketone	1	0.93	0.06	4.9	0.075	1.0012	0.021	3504	3529	0.019	0.001	0.001
278	MIK	Methyl Isobutyl Ketone	1	0.8	1.15	3.45	0.087	1.0230	0.026	3581	3887	0.023	0.001	0.001
281	MNA	1-Methyl Naphthalene	1	1.02	0.01	4.91	0.074	1.0002	0.021	3501	3504	0.019	0.001	0.001
283	MPN	2-Methyl-1-Pentene	1	0.69	6.3	2.9	0.130	1.1260	0.047	3941	5230	0.042	0.002	0.002
284	MTN	5-Methyl-1-Pentene	1	0.67	8.49	2.9	0.149	1.1698	0.059	4094	5828	0.053	0.003	0.003
286	MBE	Methyl Tert-Butyl Ether (MTBE)	1	0.74	0.04	3.1	0.074	1.0008	0.021	3503	3511	0.019	0.001	0.001
288	MNS	Mineral Spirits	1	0.75	0.2	4.3	0.077	1.0040	0.022	3514	3586	0.020	0.001	0.001
289	MRE	Myrcene	1	0.8	0.17	4.7	0.077	1.0034	0.022	3512	3581	0.020	0.001	0.001
295	NSV	Naphtha: Solvent	1	0.87	0.2	3.5	0.076	1.0040	0.022	3514	3569	0.020	0.001	0.001
296	NSS	Naphtha: Stoddard Solvant	1	0.78	0.2	4.3	0.077	1.0040	0.022	3514	3586	0.020	0.001	0.001
297	NVM	Naphtha: Varnish Maker's and Painters (75%)	1	0.77	0.19	4.3	0.077	1.0038	0.022	3513	3582	0.020	0.001	0.001
300	NAX	Nonane (all isomers)	1	0.72	0.27	4.4	0.078	1.0054	0.023	3519	3619	0.020	0.001	0.001
301	NAN	Nonane	1	0.72	0.27	4.4	0.078	1.0054	0.023	3519	3619	0.020	0.001	0.001
304	NON	Nonene	1	0.73	0.35	4.3	0.079	1.0070	0.023	3525	3651	0.021	0.001	0.001
305	NNS	Nonyl Alcohol (all isomers)	1	0.94	0.1	5	0.076	1.0020	0.022	3507	3550	0.020	0.001	0.001
306	NNN	Nonyl Alcohol	1	0.94	0.1	5	0.076	1.0020	0.022	3507	3550	0.020	0.001	0.001
307	NNI	Nonyl Alcohol (iso-)	1	0.94	0.1	5	0.076	1.0020	0.022	3507	3550	0.020	0.001	0.001
309	NNP	Nonyl Phenol	1	0.95	0.01	7.8	0.074	1.0002	0.021	3501	3507	0.019	0.001	0.001
316	DAX	Octane (all isomers)	1	0.7	0.79	3.9	0.064	1.0158	0.025	3555	3805	0.022	0.001	0.001

317 OAN	Octane	1	0.7	0.79	3.9	0.084	1.0158	0.025	3555	3805	0.022	0.001	0.001
320 OTA	Octanol	1	0.83	0.01	4.48	0.074	1.0002	0.021	3501	3504	0.019	0.001	0.001
322 OTE	Octene (1-)	1	0.72	1	3.86	0.087	1.0200	0.026	3570	3880	0.023	0.001	0.001
324 OCX	Octyl Alcohol (iso-, n-) ( all isomers), See Octanol (1	1	0.83	0.01	4.48	0.074	1.0002	0.021	3501	3504	0.019	0.001	0.001
325 IQA	Octyl Alcohol	1	0.83	0.01	4.48	0.074	1.0002	0.021	3501	3504	0.019	0.001	0.001
364 OTW	Fuel: No. 2	1	0.88	0.56	8	0.092	1.0112	0.027	3539	3955	0.024	0.001	0.001
366 OFR	Fuel: No. 4	1	0.9	0.15	3.4	0.075	1.0030	0.022	3511	3550	0.019	0.001	0.001
367 OFV	Fuel: No. 5	1	0.94	0.15	3.4	0.075	1.0030	0.022	3511	3550	0.019	0.001	0.001
368 OSX	Fuel: No. 6	1	0.95	0.15	3.4	0.075	1.0030	0.022	3511	3550	0.019	0.001	0.001
382 OIL	OIL, Misc: Crude	1	0.95	0.15	3.4	0.075	1.0030	0.022	3511	3550	0.019	0.001	0.001
383 ODS	OIL, Misc: Diesel	1	0.9	0.69	3.4	0.081	1.0138	0.024	3548	3730	0.022	0.001	0.001
389 OLB	OIL, Misc: Lubricating	1	0.9	0.15	1	0.074	1.0030	0.021	3511	3510	0.019	0.001	0.001
403 ORS	OIL, Misc: Resin	1	1.02	0.15	1	0.074	1.0030	0.021	3511	3510	0.019	0.001	0.001
418 OTB	OIL, Misc: Turbine	1	0.87	0.3	5.4	0.080	1.0060	0.023	3521	3665	0.021	0.001	0.001
429 PDC	Pentadecanol, See Alcohols (C13 and above)	1	0.83	0.01	7.88	0.074	1.0002	0.021	3501	3507	0.019	0.001	0.001
433 IPT	Pentane (iso-)	5	0.62	27	2.48	0.335	1.5400	0.228	5390	11501	0.205	0.012	0.011
434 PTA	Pentane (n-)	5	0.63	20.44	2.5	0.256	1.4088	0.146	4931	9191	0.131	0.008	0.007
437 PTE	Pentene (1-)	5	0.64	24.9	2.4	0.299	1.4980	0.193	5243	10568	0.173	0.010	0.009
442 PIN	Pinene	1	0.86	0.35	4.7	0.080	1.0070	0.023	3525	3666	0.021	0.001	0.001
448 PLB	Polybutene	1	0.91	0.01	79.3	0.077	1.0002	0.022	3501	3586	0.020	0.001	0.001
457 PGC	Polypropylene Glycol	1	1.01	0.1	1	0.074	1.0020	0.021	3507	3506	0.019	0.001	0.001
464 IAC	Propyl Acetate (iso-)	1	0.89	1.8	3.52	0.095	1.0360	0.029	3626	4115	0.026	0.002	0.001
465 PAT	Propyl Acetate (n-)	1	0	1.85	3.52	0.095	1.0370	0.029	3630	4132	0.026	0.002	0.001
466 IPA	Propyl Alcohol (iso-)	1	0.79	3	2.07	0.089	1.0600	0.029	3710	4071	0.028	0.001	0.001
467 PAL	Propyl Alcohol (n-)	1	0.8	1.2	2.07	0.080	1.0240	0.024	3584	3727	0.021	0.001	0.001
468 PBZ	Propylbenzene (n-)	1	0.86	0.2	4.14	0.077	1.0040	0.022	3514	3583	0.020	0.001	0.001
469 IPX	Iso-Propylcyclohexane	1	0.8	0.01	4.35	0.074	1.0002	0.021	3501	3503	0.019	0.001	0.001
473 PPG	Propylene Glycol (1,2-Propandiol)	1	1.04	0.01	2.62	0.074	1.0002	0.021	3501	3502	0.019	0.001	0.001
476 PME	Propylene Glycol Methyl Ether	1	0.92	0.7	3.11	0.081	1.0140	0.024	3549	3711	0.021	0.001	0.001
488 SFL	Sulfolane	1	1.26	0.01	4.14	0.074	1.0002	0.021	3501	3503	0.019	0.001	0.001
493 TTN	Tetradecanol	1	0.82	0	7.39	0.074	1.0000	0.021	3500	3499	0.019	0.001	0.001
494 TTD	1-Tetradecene, See the olefin or Alpha-Olefin Entries	1	0.77	0.01	6.77	0.074	1.0002	0.021	3501	3506	0.019	0.001	0.001
496 TTG	Tetraethylene Glycol	1	1.12	0.01	6.7	0.074	1.0002	0.021	3501	3506	0.019	0.001	0.001
497 THN	Tetrahydronaphthalene	1	0.97	0.04	4.56	0.074	1.0008	0.021	3503	3518	0.019	0.001	0.001
499 TOL	Toluene	1	0.87	1.5	3.14	0.089	1.0300	0.027	3605	3955	0.024	0.001	0.001
502 TCP	Tricresyl Phosphate (less than 1% of the ortho isom	1	1.16	0.01	12.69	0.074	1.0002	0.021	3501	3513	0.019	0.001	0.001
503 TRD	Tridecane	1	0.76	0.02	6.4	0.074	1.0004	0.021	3501	3512	0.019	0.001	0.001
505 TDN	Tridecanol , See Alcohols (C13 and above)	1	0.85	0.01	6.91	0.074	1.0002	0.021	3501	3506	0.019	0.001	0.001
506 TDC	1-Tridecene	1	0.77	0.01	6.29	0.074	1.0002	0.021	3501	3506	0.019	0.001	0.001
508 TEB	Triethylbenzene	1	0.86	0.02	5.6	0.074	1.0004	0.021	3501	3511	0.019	0.001	0.001
509 TEG	Triethylene Glycol	1	1.12	0.01	5.17	0.074	1.0002	0.021	3501	3504	0.019	0.001	0.001
519 TRE	Trimethylbenzenes (all isomers)	1	0.89	0.14	4.2	0.076	1.0028	0.022	3510	3559	0.020	0.001	0.001
520 TMB	Trimethyl Benzene (1,2,5-)	1	0.89	0.14	4.14	0.076	1.0028	0.022	3510	3558	0.020	0.001	0.001
521 TMD	Trimethyl Benzene (1,2,3-)	1	0.89	0.14	4.14	0.076	1.0028	0.022	3510	3558	0.020	0.001	0.001
522 TME	Trimethyl Benzene (1,2,4-) (Pseudocumene)	1	0.89	0.14	4.14	0.076	1.0028	0.022	3510	3558	0.020	0.001	0.001
529 TRP	Trixylenyl Phosphate	1	1.16	0	14.2	0.074	1.0000	0.021	3500	3499	0.019	0.001	0.001
546 XLX	Xylenes (Ortho-, meta-, para-)	1	0.89	0.51	3.66	0.080	1.0102	0.023	3536	3684	0.021	0.001	0.001
547 XLM	Xylene (M-)	1	0.87	0.51	3.66	0.080	1.0102	0.023	3536	3684	0.021	0.001	0.001
548 XLO	Xylene (O-)	1	0.89	0.4	3.66	0.079	1.0080	0.023	3528	3645	0.021	0.001	0.001
549 XLP	Xylene (P-)	1	0.86	0.51	3.66	0.080	1.0102	0.023	3536	3684	0.021	0.001	0.001
550 XYL	Xylenol	1	1.01	0.1	3.66	0.075	1.0020	0.022	3507	3536	0.019	0.001	0.001
551	Zinc Dialkyldithiophosphate												
	Max.		1.260	27.000	79.300	0.335	1.540	0.228	5390	11501	0.205	0.012	0.011
	Min.		0.000	0.000	1.000	0.000	1.000	0.021	3500	3499	0.019	0.000	0.000

\*when barge vapor piping is connected to facility vapor recovery system.

# LIQUID TRANSFER RATE vs PRESSURE DROP



# PRESSURE vs MAXIMUM TRANSFER RATE (FOR SUB-CHAPTER "D" CARGOES)

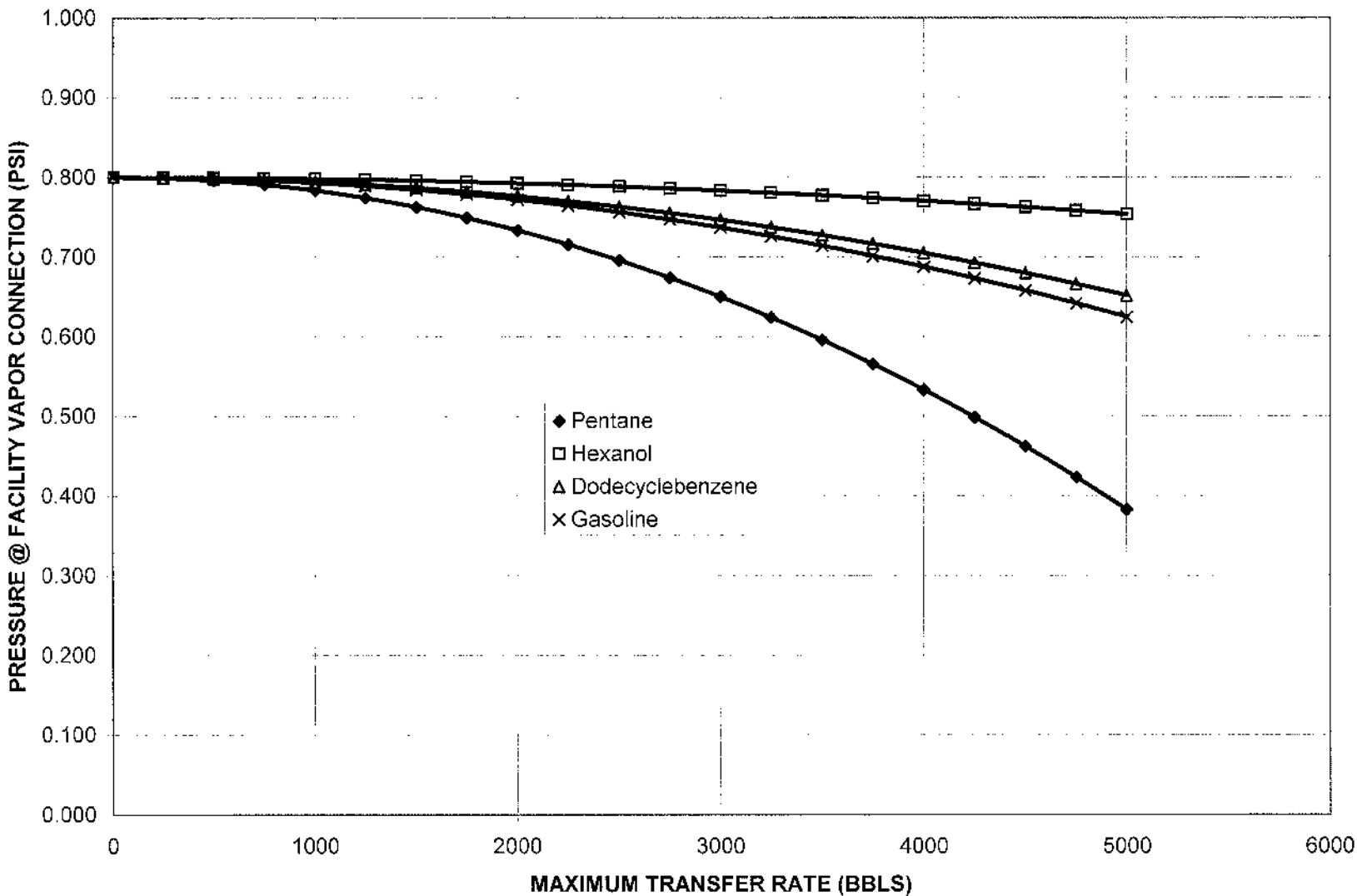
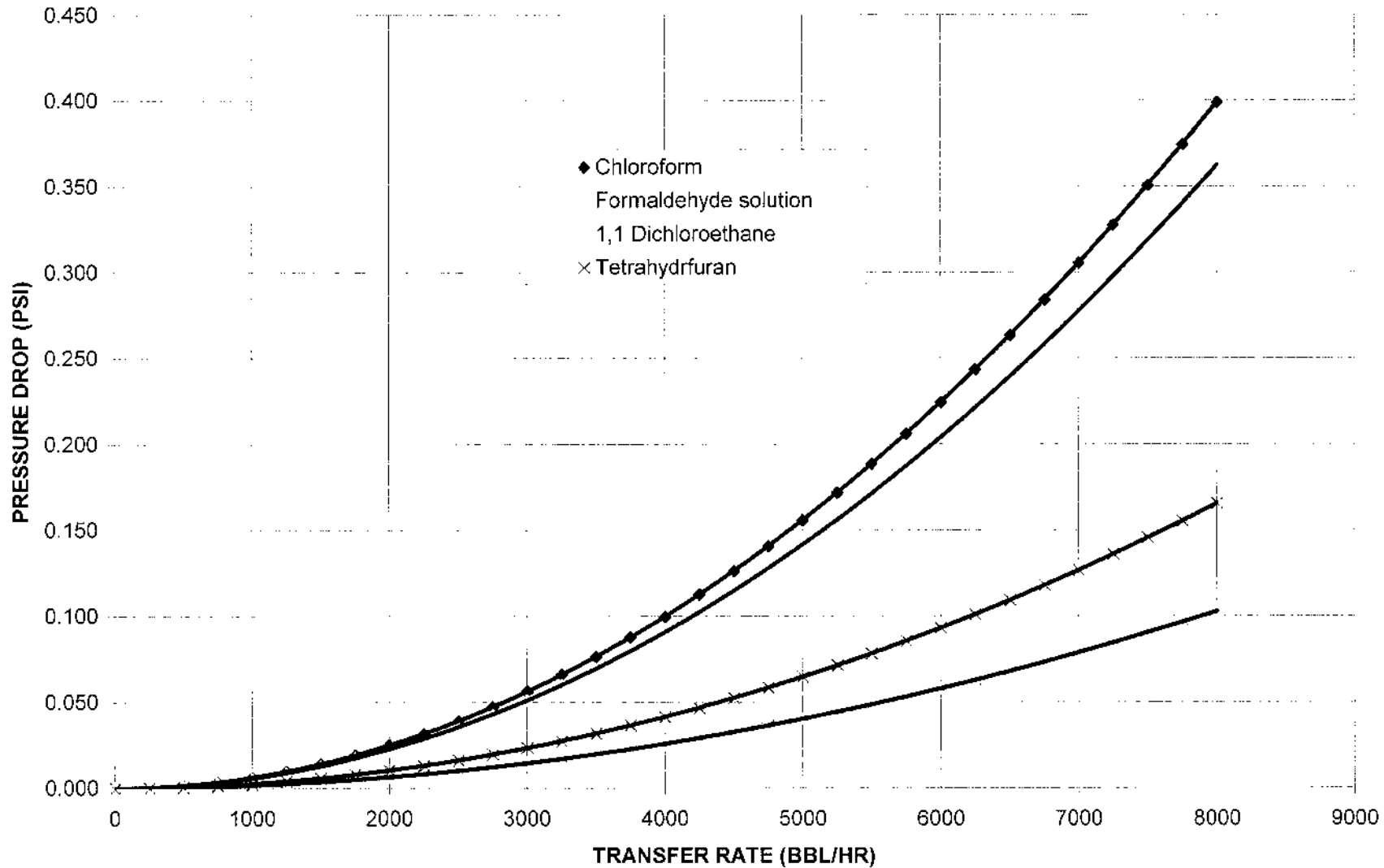


TABLE 4 (SUBCHAPTER "O" CARGOES)

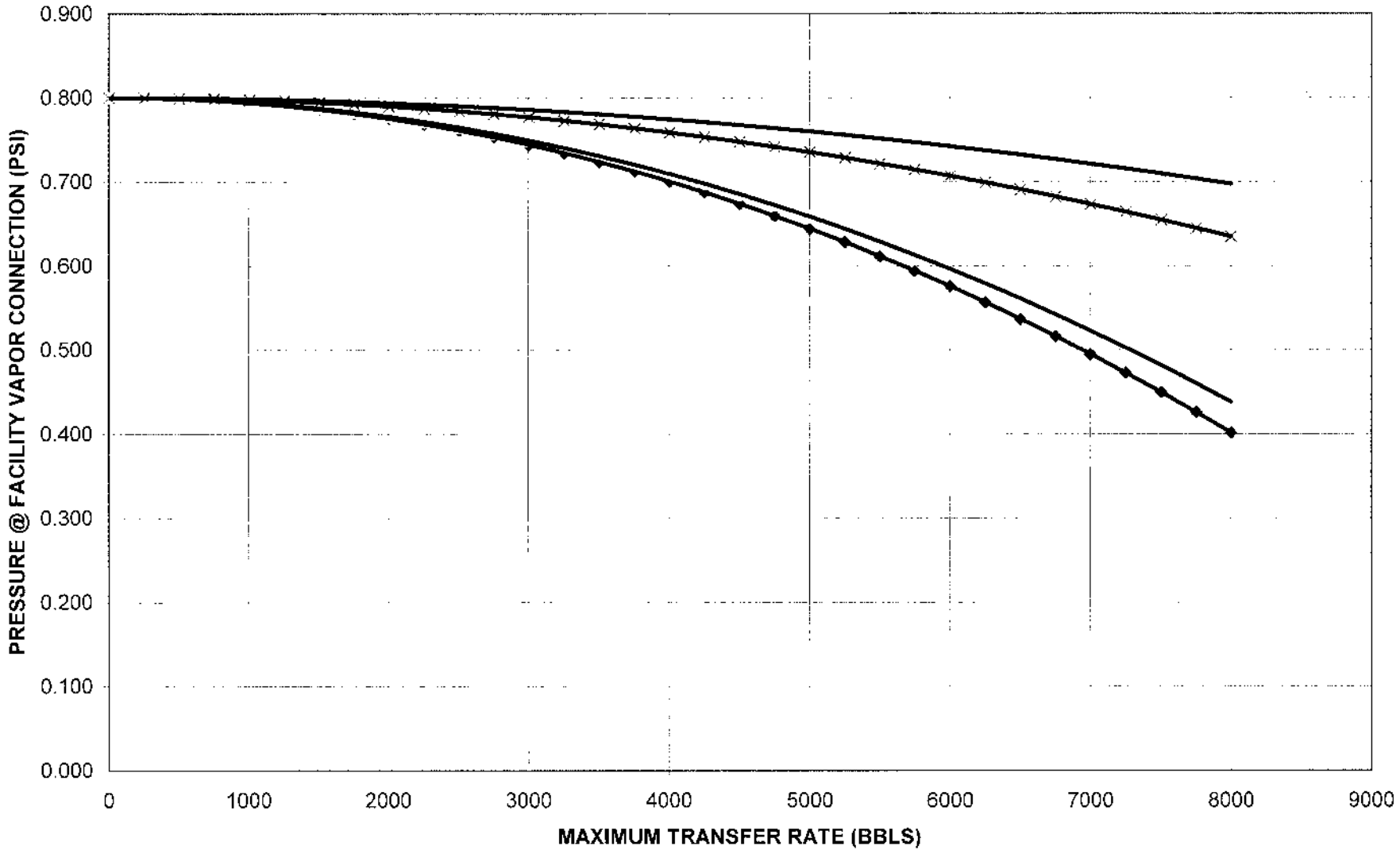
CHRIS CODE	NAME	VCS CAT	LIQ SG	VAPOR PRESS	VAPOR SG	VAPOR AIR WEIGHT DENSITY	VAPOR GROWTH RATE	PRESSURE DROP TO PV VALVE IN VCS(psig) (LOADING)	VAPOR VOLUMETRIC FLOW RATE (bbt/h)	AIR EQUIVALENT VOLUMETRIC FLOW RATE	PRESSURE	PRESSURE	PRESSURE
											DROP TO SHORE CONNECTION IN VCS (psig) (LOADING)*	DROP TO PV VALVE IN VCS(psig) (UNLOADING)	DROP TO SHORE CONNECTION IN VCS (psig) (UNLOADING)*
1 ACN	Acrylonitrile	4	0.81	5.00	1.80	0.095	1.1000	0.033	3850	4298	0.029	0.002	0.002
2 ADN	Adiponitrile	1	0.95	0.01	3.73	0.076	1.0002	0.022	3501	3503	0.020	0.001	0.001
3 ATN	Acetonitrile	3	0.78	0.03	1.41	0.076	1.0006	0.022	3502	3502	0.020	0.001	0.001
4 BAD	Iso-Butylaldehyde	1	0.80	7.80	2.50	0.131	1.1580	0.050	4046	5308	0.045	0.003	0.002
5 BAR	Butyl acrylate (Iso-, n-)	2	0.90	0.60	4.42	0.086	1.0120	0.025	3542	3759	0.023	0.001	0.001
6 BMH	Butyl Methacrylate	2	0.88	0.29	4.9	0.081	1.0058	0.024	3520	3640	0.021	0.001	0.001
7 BNZ	Benzene	1	0.88	4.50	2.80	0.114	1.0900	0.039	3815	4671	0.035	0.002	0.002
8 BTR	n-Butylaldehyde	1	0.80	7.80	2.50	0.131	1.1580	0.050	4046	5308	0.045	0.003	0.002
9 BTX	Benzene, Toluene, Xylene mixtures (10% Benzene or more)	1	0.84	7.30	2.80	0.138	1.1460	0.052	4011	5396	0.046	0.003	0.002
10 CCH	Cyclohexanone	1	0.95	0.20	3.40	0.078	1.0040	0.023	3514	3585	0.020	0.001	0.001
11 CHA	Cyclohexylamine	1	0.87	0.62	3.42	0.083	1.0124	0.024	3543	3703	0.022	0.001	0.001
12 CRB	Chlorobenzene	1	1.11	0.80	3.88	0.087	1.0160	0.026	3566	3799	0.023	0.001	0.001
13 CRF	Chloroform	3	1.48	9	4.25	0.213	1.1800	0.085	4130	6916	0.076	0.004	0.004
14 NCT	Coal Tar Naphtha Solvent	1	0.86	0.2	4	0.079	1.0040	0.023	3514	3577	0.020	0.001	0.001
15 CRS	Cresols	1	1.05	0.06	3.72	0.077	1.0012	0.022	3504	3521	0.020	0.001	0.001
16 CTA	Crotonaldehyde	4	0.85	2	2.41	0.089	1.0400	0.028	3640	3943	0.025	0.001	0.001
17 DCH	1,1-Dichloroethane	1	1.18	9.90	3.41	0.188	1.1980	0.077	4193	6592	0.069	0.004	0.004
18 DPP	1,2-Dichloropropane	3	1.16	2.5	3.88	0.110	1.0500	0.035	3675	4418	0.031	0.002	0.002
19 DPU	1,3-Dichloropropene	4	1.23	5.5	3.84	0.149	1.1100	0.053	3885	5443	0.047	0.003	0.002
20 DEN	Diethylamine	3	0.71	1.00	2.50	0.083	1.0200	0.025	3570	3731	0.022	0.001	0.001
21 DIP	Diisopropanolamine	1	0.98	0.01	4.59	0.076	1.0002	0.022	3501	3504	0.020	0.001	0.001
22 DMF	Dimethylformamide	1	0.95	0.30	2.51	0.078	1.0060	0.023	3521	3569	0.020	0.001	0.001
23 DPX	1,1-,1,2-, or 1,3-Dichloropropane	3	1.16	6.30	3.90	0.162	1.1260	0.059	3941	5747	0.053	0.003	0.003
24 EAC	Ethyl acrylate	2	0.93	2.00	3.50	0.099	1.0400	0.031	3640	4163	0.028	0.002	0.001
25 EAI	2-Ethylhexyl acrylate	2	0.89	0.02	6.35	0.076	1.0004	0.022	3501	3512	0.020	0.001	0.001
26 EDC	Ethylene dichloride	1	1.26	4.00	3.42	0.121	1.0800	0.041	3780	4776	0.036	0.002	0.002
27 ETM	Ethyl Methacrylate	2	0.92	1	3.84	0.090	1.0200	0.027	3570	3879	0.024	0.001	0.001
28 EPA	2-Ethyl-3-propylacrolein	1	0.85	0.12	4.5	0.078	1.0024	0.022	3508	3553	0.020	0.001	0.001
29 FFA	Furfural	1	1.20	0.15	3.31	0.078	1.0030	0.022	3511	3547	0.020	0.001	0.001
30 FMS	Formaldehyde solution (37% to 50%)	1	1.13	0.15	1.03	0.076	1.0030	0.022	3511	3510	0.020	0.001	0.001
31 MSO	Mesityl Oxide	1	0.86	0.67	3.5	0.084	1.0134	0.025	3547	3725	0.022	0.001	0.001
32 MAM	Methyl acrylate	2	0.95	4.10	3.00	0.114	1.0820	0.038	3787	4646	0.034	0.002	0.002
33 MBE	Methylcyclopentadiene dimer	1	0.74	0.04	3.10	0.076	1.0008	0.022	3503	3511	0.020	0.001	0.001
34 MMM	Methyl methacrylate	2	0.94	2.02	3.45	0.099	1.0404	0.031	3641	4159	0.028	0.002	0.001
35 MPL	Morpholine	1	1.00	0.80	3.00	0.083	1.0160	0.025	3556	3726	0.022	0.001	0.001
36 NPM	1- or 2-Nitropropane	1	0.99	1.05	3.06	0.086	1.0210	0.028	3574	3804	0.023	0.001	0.001
37 PRD	Pyridine	1	0.98	1.30	2.72	0.086	1.0260	0.026	3591	3830	0.023	0.001	0.001
38 STY	Styrene	2	0.92	0.40	3.60	0.081	1.0080	0.024	3528	3638	0.021	0.001	0.001
39 TCN	1,2,3-Trichloropropane	3	1.39	0.15	5.60	0.079	1.0030	0.023	3511	3583	0.020	0.001	0.001
40 TEN	Triethylamine	3	0.73	2.50	3.49	0.105	1.0500	0.033	3675	4323	0.030	0.002	0.002
41 THF	Tetrahydrofuran	1	0.89	8.50	1.35	0.090	1.1700	0.035	4095	4454	0.032	0.002	0.002
42 VAM	Vinyl acetate	2	0.94	5.80	2.97	0.130	1.1160	0.046	3906	5099	0.042	0.002	0.002
		Max.	1.39	12.5	8.40	0.213	1.198	0.085	4193	6916	0.076	0.004	0.004
		Min.	0.63	0.01	1.03	0.076	1.000	0.022	3501	3502	0.020	0.001	0.001

\*when barge vapor piping is connected to facility vapor recovery system.

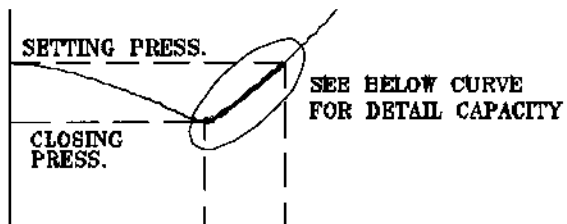
# LIQUID TRANSFER RATE vs PRESSURE DROP



# PRESSURE vs MAXIMUM TRANSFER RATE (FOR SUB-CHAPTER "O" CARGOES)



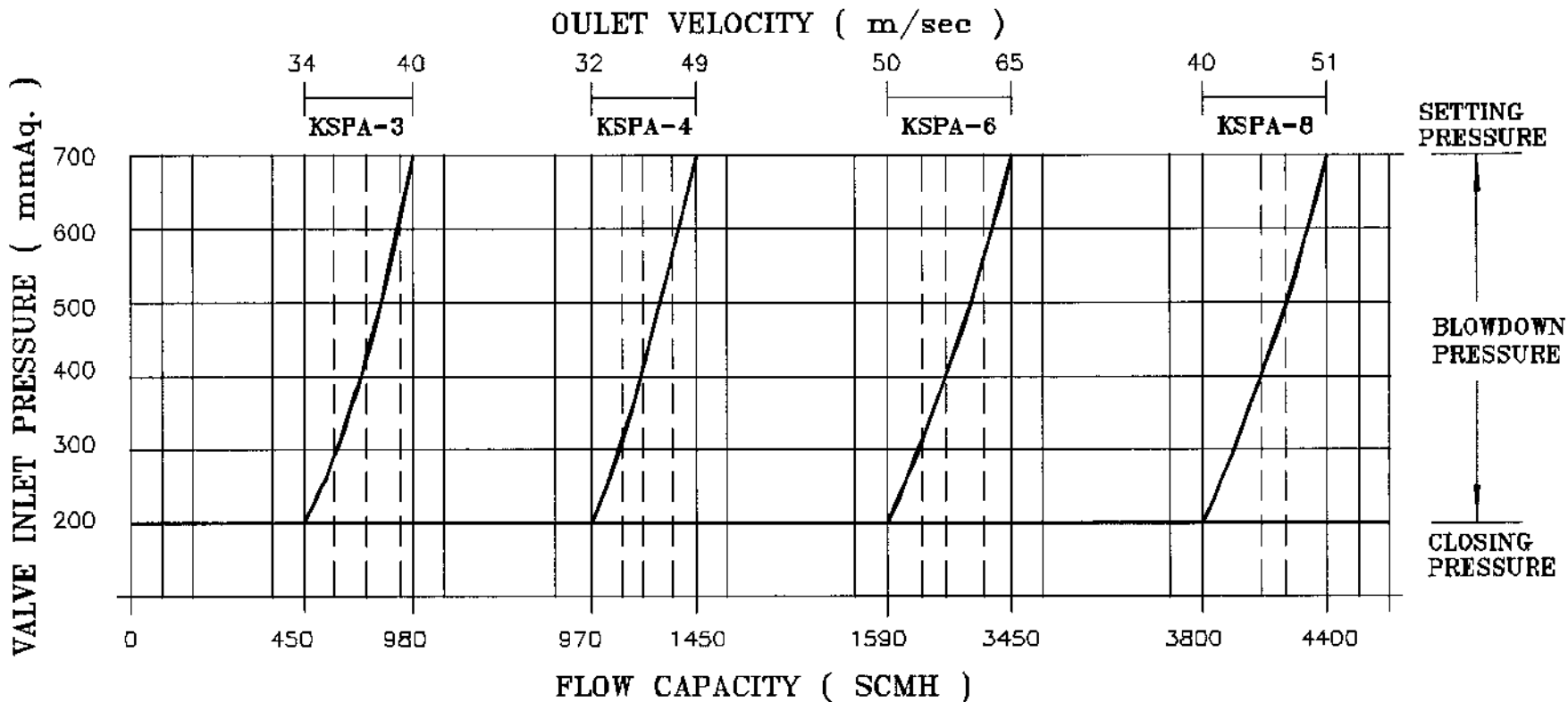
PROGRESS OF VALVE PRESSURE



TANKTECH HIGH VELOCITY VENT VALVES

KSPA TYPE FLOW CAPACITY CURVE

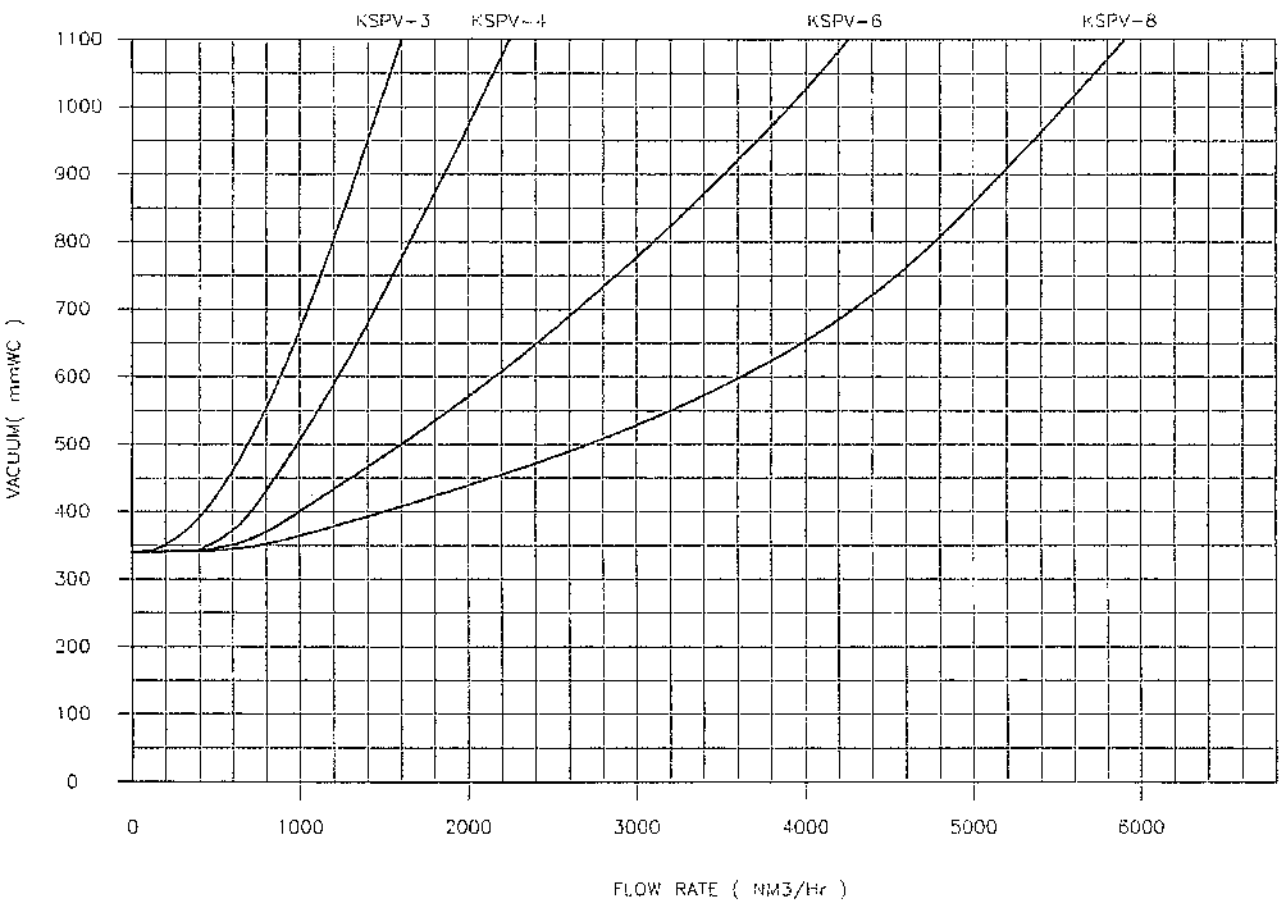
700 mmAq. SETTING PRESSURE



(1)

# FLOW CAPACITY CURVE GRAPH

FLOW TEST PERFORMED ON EQUIPMENT  
USING AIR, AT TEMP. T=15.6°C AND  
AMBIENT PRESSURE P=1.0332 KG/CM<sup>2</sup>.



# TANKTECH

TITLE

HIGH VELOCITY VACUUM RELIEF VALVE

KSPV TYPE

(12)



## Marine Safety Center Vapor Control System (VCS) Plan Review Information Sheet (PRIS)



<b>Vessel Name</b>	CBC 1335 thru CBC 1359	<b>Shipyard</b>	Southwest
<b>Official Number</b>	0	<b>Hull Number</b>	9628 thru 9652

1. This sheet consolidates critical VCS parameters for MSC Staff Engineers and CG Field Inspectors dealing with Vapor Control Systems. CG Inspectors should verify the vessel's VCS design is consistent with the information listed in boxes 2, 6, 7 & 8 prior to updating the vapor control endorsement on the vessel's Certificate of Inspection. For cases where the information in the VCS PRIS does not reflect the vessel's design the CG Inspector should contact the MSC's Cargo Authority branch.

<b>2. Tank Maximum Design Working Pressure</b>	<input style="width: 80%;" type="text" value="3.50"/>	psig	<b>Raised Trunk</b> <input checked="" type="checkbox"/>
			<b>Flush Deck</b>
<b>3. Authorized Maximum Cargo Transfer Rate(s)</b>	<input style="width: 80%;" type="text" value="3500"/>	bbl/hr loading (max 2 tanks simultaneously)	
	<input style="width: 80%;" type="text" value="800"/>	bbl/hr discharging	
<b>4. Authorized Maximum Cargo Density</b>	<input style="width: 80%;" type="text" value="0.346"/>	lbm/ft <sup>3</sup>	
<b>5. Authorized VCS Categories</b>	<input style="width: 80%;" type="text" value="1 through 7"/>		

**6. Cargoes with the highest vapor density and/or pressure drop:**

a. Cargo Name                     Iso-Pentane (PTY)                    

b. Cargo Name                     Iso-Pentane (PTY)                    

<b>7. Pressure Vacuum Valve:</b>		<b>8. VCS Pipe Sizes:</b>	
<b>Manufacturer</b>	<input style="width: 80%;" type="text" value="BERGAN KLPH"/>	<b>Approx. Inside Diameter</b>	
<b>Size</b>	<input style="width: 80%;" type="text" value="6"/>	<b>Longitudinal Header (inches)</b>	<input style="width: 80%;" type="text" value="8"/>
<b>CG Approval</b>	<input style="width: 80%;" type="text" value="162.017/0000144/3"/>	<b>Transverse Header (Inches)</b>	<input style="width: 80%;" type="text" value="8"/>
<b>Settings in psig:</b>			
	Pressure-side <input style="width: 80%;" type="text" value="1"/>		
	Vacuum-side <input style="width: 80%;" type="text" value="0.5"/>		
<b>Required Venting Capacity of Pressure-Side of P/V valve</b>		<input style="width: 80%;" type="text" value="11504"/>	bbl/hr (air)
<b>Required Venting Capacity of Vacuum-Side of P/V valve</b>		<input style="width: 80%;" type="text" value="800"/>	bbl/hr (air)

**9. Tank Overfill Protection System** (check appropriate box or boxes)

a. High Level/Tank Overfill Alarm	<input checked="" type="checkbox"/>	Type	<input style="width: 80%;" type="text" value="BERGAN GUARD"/>	<b>Meets ASTM F1271</b>	<b>Setting in psig</b> <input style="width: 80%;" type="text" value="N/A"/>
b. Overfill Control Shutdown	<input checked="" type="checkbox"/>	Type	<input style="width: 80%;" type="text" value="BERGAN GUARD"/>		
c. Spill Valve	<input type="checkbox"/>	Type	<input style="width: 80%;" type="text" value="N/A"/>		
d. Rupture Disk	<input type="checkbox"/>	Type	<input style="width: 80%;" type="text" value="N/A"/>		

**10. Closed Gauging**     Verify the vessel has closed gauging that satisfies 46 CFR 39.20-3 and 151.15-10(c).

**11. Instructions/Guidelines for the OCMI:**

11a. The following is the Marine Safety Center's recommended COI endorsement:

In accordance with 46 CFR Part 39, excluding part 39.40, this vessel's vapor collection system has been inspected to the plans approved by Marine Safety Center letters Serial # C1-1101625 dated May 27, 2011, and has been found acceptable for the collection of bulk liquid cargo vapors annotated with "Yes" in the CAA's VCS column of the vessel's Cargo Authority Attachment, Serial #C1-1101625.

When the vessel is carrying cargoes containing greater than 0.5% benzene, the person in charge is responsible for ensuring the provisions of 46 US Code of Federal Regulations Part.197, Subpart C are applied.

11b. The MSC approval letter/s must be available at the OCMI's request.

11c. Verify isolation valve at the vapor connection flange is manually operable and designed in a way it is "clearly" open or closed.

11d. Previous applicable approval letters:

VCS Approval Letter	<input style="width: 90%;" type="text" value="C1-1101625 dated May 27, 2011"/>	MSC Plan Reviewer	<input style="width: 90%;" type="text" value="LT M. D. Armstrong"/>
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