

TRINITY MARINE PRODUCTS, INC.

**ASHLAND CITY, TN - MADISONVILLE, LA
CARUTHERSVILLE, MO – PORT ALLEN, LA**

VAPOR CONTROL SYSTEM (VCS) CALCULATIONS

**FOR
DUAL LOADING AND DISCHARGE
OF
SUBCHAPTER "D" & "O" PRODUCTS
FOR
Canal Barge Company**

TRINITY MARINE PRODUCTS TAG No.: 38201

TRINITY - MADISONVILLE HULL No.: 2207-1 Thru 4

USCG MSC PROJECT No.: P017865

July 1, 2013

Prepared By:

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OWNER: Canal Barge Company
DESCRIPTION: Single Rake, Double Skin, Inland Tank Barge
SIZE: 297'-6"x54'-0"x12'-0"
HULL/NAME: 2207-1 Thru 4/CBC 313 - CBC 316

CONTRACT: 38201
BY: MEC
DATE: 1-Jul-13

VCS SYSTEM INFORMATION

1. GENERAL DESCRIPTION OF VESSEL:

A. TMP HULL NUMBERS: 2207-1 Thru 4
B. NAME (S): CBC 313 - CBC 316
C. OFFICIAL NUMBER: 1244509 - 1244512
D. USCG MSC FILE NUMBER: P017865
E. DIMENSIONS: 297'-6"x54'-0"x12'-0"
F. SERVICE: Rivers, Lakes, Bays and Sounds, Subchapter "D" and "O"
G. MAX. ALLOWABLE WORKING PRESSURE: 3.00 psig
H. PV VALVE PRESSURE SETTING: 1.50 psig
I. PV VALVE VACUUM SETTING: 0.50 psi
J. MAX. DISCHARGE RATE: 5000 bbl/hr 468cuft/min
K. MAX. LIQUID LOADING RATE: 5000 bbl/hr 468cuft/min

2. VAPOR CONTROL SYSTEM

A. PIPE DIAMETER: 7.981 in
B. PIPE LENGTHS: See Trinity Drawing 38201P-06
C. P/V VALVE I.C. BERGAN KLPH-6 PV

COMP	MAX FLOW	MAX PRESSURE DROP ACROSS VALVE
I.C. BERGAN KLPH-6 PV	36000bbl/hr @ 1.5psi	0.943psi @ 13350bbl/hr Air
I.C. BERGAN KLPH-6 PV	26000bbl/hr @ 0.5psi	0.530psi @ 5000bbl/hr Air

D. MAX. VAPOR-AIR MIXTURE DENSITY: 0.347 lbs/ft³
E. DARCY FRICTION FACTOR: 0.014
F. VCS CARGOES: SEE TABLE 1
G. SPILL VALVE None Installed
H. ADDITIONAL INFORMATION:

- 46CFR39.20-1(a)(4) SYSTEM IS DESIGNED WITH SEVERAL LOW POINT CONDENSATE DRAINS.
- 46CFR39.20-1(a)(5) SYSTEM IS ELECTRICALLY BONDED TO THE VESSEL DUE TO WELDED STEEL CONSTRUCTION
- 46CFR39.20-1(c) SYSTEM INCLUDES AN ISOLATION VALVE, MANUALLY OPERATED GATE VALVE, AT EACH FACILITY CONNECTION
- 46CFR39.20-1(d) VAPOR HEADER MARKED AS SHOWN IN TRINITY DWG P-6
- 46CFR39.20-1(e) FACILITY CONNECTION FLANGE FITTED WITH 1/2" STUD 1" LONG AT LOCATION OUTLINED IN REGULATION
SYSTEM IS DESIGNED TO ACCOMMODATE INTERNAL VISUAL INSPECTION AS REQUIRED FOR CARRIAGE OF POLYMERIZING CARGOES.

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VCS CALCULATIONS

1. CARGO AUTHORITY:

The vapor collection system installed on this vessel is designed to carry the cargoes listed in Table 1. These Cargoes are to be listed on the vessel's Certificate of Inspection.

2. DETERMINING VAPOR AIR MIXTURE DENSITY AND VAPOR GROWTH RATE:

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

3. THE MAXIMUM LIQUID TRANSFER RATE AS IMPOSED BY THE CAPACITY OF THE CARGO VENTING SYSTEM 46CFR39.30-1:

A: PRESSURE DROP FROM TANK TO PV VALVE

Tank 1 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	K	D (in)	UNIT EQ. LENGTH (FT)	TOTAL EQ. LENGTH (FT)	
Entrance, Projecting	1.00	0.780	7.981	37.05	37.05	
Straight Pipe	10.06		7.981	1.00	10.06	
Tee Branch Con	2.00	1.100	7.981	52.26	104.51	Tank Drop
Tee Run Con	1.00	0.550	7.981	26.13	26.13	177.75
Straight Pipe	104.08		7.981	1.00	104.08	
Tee Branch Div	2.00	1.040	7.981	49.41	98.81	
Tee Run Con	1.00	0.550	7.981	26.13	26.13	
Total					406.78	

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 #1 cargo tank and the P/V valve for each cargo is shown in Table 1.

Using a 5000 bbl/h liquid transfer rate, the vapor-air mixture and air-equivalent volumetric flow rate for each cargo are given in Table 1. At a setting of 1.5 psig, the I.C. BERGAN KLPH-6 PV has an adequate pressure relieving capacity of air for each cargo listed in Table 1. The maximum pressure in the tank, 1.5 psi, based on a pressure drop of 0.0 psig in piping and 1.5 psig across the PV Valve at 0 bbl air equivalent, does not exceed the cargo tank maximum design working pressure of 3.0 psi.

Pressure Drop of Air Flow Into Tanks During Discharge

NAME	ρ @ 115°F (LBS/CUFT)	f	PIPE DIA (FT)	TOTAL EQ. LENGTH (FT)	FLOW RATE (CUFT/SEC)	V (FT/SEC)	PRESSURE DROP (PSI)
Air	0.069	0.014	0.665	406.78	7.80	22.45	0.032

Using a 5000 bbl/h liquid transfer rate as the air flow rate. At a setting of 0.5 psig, the I.C. BERGAN KLPH-6 PV has an adequate pressure relieving capacity of air. The maximum vacuum in the tank, 0.6 psi based on a pressure drop of 0.0 psig in piping and 0.5 psig across the PV Valve at 5000 bbl air, does not exceed the cargo tank maximum design working pressure of 3.0 psi.

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VCS CALCULATIONS (CONT)

B: PRESSURE DROP FROM TANK TO FACILITY VAPOR CONNECTION

The sum of the pressure drop along the longest path and the pressure at the facility vapor connection may not exceed 80 percent of the P/V valve setting. The total equivalent length from cargo tank #1 to the vapor connection is given in Table 3.

TABLE 3

PIPE/FITTINGS		QUANTITY	K	D (in)	UNIT EQ. LENGTH (FT)	TOTAL EQ. LENGTH (FT)	
Tank Drop		177.75		7.891	1.00	177.75	(From Above)
Straight Pipe		231.736		7.981	1.00	231.74	
Tee Run Con		2	0.55	7.981	26.13	52.26	
Tee Run Div		1	0.3	7.981	14.25	14.25	
Tee Branch Con		1	1.1	7.981	52.26	52.26	
Tee Branch Div		1	1.04	7.981	49.41	49.41	
8" Gate Valve		1	0.112	7.981	5.32	5.32	
45° Wye Branch Div		1	0.351	7.981	16.67	16.67	
Inboard Barge	Straight Pipe	35.875		7.981	1.00	35.88	
	Tee Run Con	1	0.55	7.981	26.13	26.13	
	8" Gate Valve	2	0.112	7.981	5.32	10.64	
	Cargo Hose	20		7.981	1.00	20.00	
Total						692.300	

Pressure drop at the maximum liquid loading rate of 5000bbl/h from Tank 1 to the Vapor Header Connection for each cargo is given in Table 1.

The largest pressure drop (0.4psi) does not exceed 80 percent of the P/V valve pressure setting (1.2psig).

4. THE MAXIMUM LIQUID TRANSFER RATE AS IMPOSED BY THE RELIEVING CAPACITY OF THE CARGO TANK SPILL VALVE OR RUPTURE DISK.

PROTECTION TYPE: Spill Valve
MANUFACTURER / MODEL: None Installed

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

SMALLEST TANK:	Tank No. 3
SET POINT OF OVERFILL SHUTDOWN:	10.56* IN ULLAGE FROM GAUGE FLANGE
REMAINING CAPACITY AT SHUTDOWN:	471 CUFT
MAX LOAD RATE:	468 CUFT/MIN
MAX LOAD RATE PER TANK:	5000 BBL/HR
TIME REMAINING FOR SHUTDOWN	1.0 MIN
TIME REQUIRED BY 46CFR39.20-9:	1.0 MIN
MARGIN:	0.0 MIN

*Note: Setpoint is minimum required setpoint. Actual setting will be done by Owner prior to COI.

The #3 cargo tank has a set point for the overfill shutdown set at 0.88ft BELOW THE FLANGE OF THE GAUGE. The tank capacity above this level is 471cuft. With a liquid transfer rate of 5000 bbl/h per tank based on loading into a single tank only, the person in charge of transfer operations has at least 1 minute to stop the transfer operation before the tank overflows. Thus the VCS meets the requirements of 46CFR 39.20-9.

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TABLE 1 - VAPOR CONTROL SYSTEM CALCULATIONS

	CHRIS CODE	NAME	COMP GROUP	SUB CHAP	GRADE	HULL TYPE	VCS CAT	REST.	LIQ SG	VAPOR PRESS	VAPOR SG	VAPOR AIR WEIGHT DENSITY	VAPOR GROWTH RATE	VAPOR FLOW RATE (bb/h)	AIR EQUIV FLOW RATE (bb/hr)	PRESSURE DROP TO PV VALVE IN VCS (LOADING)* (psig)	PRESSURE DROP TO SHORE CONN IN VCS (LOADING)* (psig)
1	ABX	Ammonium bisulfite solution (70% or less)	43	O	NA	III	N/A	.50-73, .56-1(a), (b), (c)	0.880	0.330	4.480		1.007	5033	5212	0.038	0.065
2	ACN	Acrylonitrile	15	O	C	II	4	.50-70(a), .55-1(e)	0.810	5.000	1.800	0.095	1.100	5500	6146	0.053	0.091
3	ADN	Adiponitrile	37	O	E	II	1	No	0.950	0.010	3.730	0.076	1.000	5001	5009	0.035	0.060
4	AEE	Aminoethylethanamine	8	O	E	III	1	.55-1(b)	1.030	0.010	3.590	0.076	1.000	5001	5009	0.035	0.060
5	AHO	Anthrane oil (Coal tar fraction)	33	O	NA	II	N/A	No	1.030	0.010	3.590	0.076	1.000	5001	5009	0.035	0.060
6	AMH	Ammonium hydroxide (28% or less NH3)	6	O	NA	III	N/A	.56-1(a), (b), (c), (f), (g)	0.940	10.600	2.640	0.158	1.212	6060	8732	0.108	0.184
7	ATN	Acetonitrile	37	O	C	III	3	No	0.780	0.030	1.410	0.076	1.001	5003	5009	0.035	0.060
8	BAR	Butyl acrylate (all isomers)	14	O	D	III	2	.50-70(a), .50-81(a), (b)	0.880	0.600	4.420	0.086	1.012	5060	5375	0.041	0.070
9	BHA	Benzene or hydrocarbon mixtures (containing Acetylene and 10% Benzene or more)	32	O	NA	III	1	.50-60, .56-1(b), (d), (f), (g)	0.880	0.800	4.000		1.250	6250	6702	0.064	0.108
10	BHB	Benzene or hydrocarbon mixtures (having 10% Benzene or more)	32	O	NA	III	1	.50-60	0.880	0.800	4.000	0.087	1.250	6250	6702	0.064	0.108
11	BMN	Butyl Methacrylate	14	O	D	III	2	.50-70(a), .50-81(a), (b)	0.880	0.290	4.900	0.081	1.006	5029	5206	0.038	0.065
12	BNZ	Benzene	32	O	C	III	1	.50-60	0.880	4.500	2.800	0.114	1.250	6250	7661	0.083	0.141
13	BTX	Benzene, Toluene, Xylene mixtures (10% Benzene or more)	32	O	B/C	III	1	.50-60	0.840	7.300	2.800	0.138	1.250	6250	8418	0.100	0.171
14	CBT	Carbon tetrachloride	36	O	NA	III	N/A	No	1.590	5.400	5.490	0.190	1.108	5540	8761	0.109	0.185
15	CCH	Cyclohexanone	18	O	D	III	1	.56-1(a), (b)	0.950	0.200	3.400	0.078	1.004	5020	5098	0.037	0.063
16	CCW	Cresote	21	O	E	III	1	No	0.950	0.200	3.400	0.078	1.004	5020	5098	0.037	0.063
17	CHA	Cyclohexylamine	7	O	D	III	1	.56-1(a), (b), (c), (g)	0.870	0.620	3.420	0.083	1.012	5062	5295	0.040	0.068
18	DCM	Dichloromethane	36	O	NA	III	5	No	1.340	19.000	3.000	0.295	1.250	6250	12317	0.215	0.365
19	DEE	2,2'-Dichloroethyl ether	41	O	D	II	1	.55-1(f)	1.220	0.040	4.900	0.077	1.001	5004	5032	0.036	0.061
20	DEN	Diethylamine	7	O	C	III	3	.55-1(e)	0.710	1.000	2.500	0.083	1.020	5100	5335	0.040	0.069
21	DET	Diethylenetriamine	7	O	E	III	1	.55-1(c)	0.950	0.040	3.480	0.077	1.001	5004	5023	0.036	0.061
22	DIA	Diisopropylamine	7	O	C	II	3	.55-1(e)	0.720	3.700	3.500	0.120	1.074	5370	6736	0.064	0.109
23	DIP	Diisopropylamine	8	O	E	III	1	.55-1(c)	0.980	0.010	4.590	0.076	1.000	5001	5010	0.036	0.060
24	DMB	Dimethylethanamine	8	O	D	III	1	.56-1(b), (c)	0.890	0.516	3.030	0.081	1.010	5052	5216	0.038	0.066
25	DMF	Dimethylformamide	10	O	D	III	1	.55-1(e)	0.950	0.300	2.510	0.078	1.006	5030	5104	0.037	0.063
26	DMX	Dichloropropene, Dichloropropane mixtures.	15	O	NA	II	1	No	0.892	9.200	1.550	0.100	1.184	5920	6787	0.065	0.111
27	DNA	Di-n-propylamine	7	O	C	II	3	.55-1(a)	0.740	1.450	3.500	0.093	1.029	5145	5696	0.046	0.078
28	DOT	Dodecyl(dimethyl)amine, Tetradecyl(dimethyl)amine mixture	7	O	E	III	N/A	.56-1(b)	0.990	0.010	13.450	0.077	1.000	5001	5024	0.036	0.061
29	DPB	1,1-Dichloropropane	36	O	C	III	3	No	1.040	1.800	3.000	0.093	1.036	5180	5731	0.046	0.079
30	DPC	1,3-Dichloropropane	36	O	C	III	3	No	1.040	1.800	3.000	0.093	1.036	5180	5731	0.046	0.079
31	DPP	1,2-Dichloropropane	36	O	C	III	3	No	1.160	2.500	3.890	0.110	1.050	5250	6318	0.056	0.096
32	DPU	1,3-Dichloropropane	15	O	D	II	4	No	1.230	5.500	3.840	0.150	1.110	5550	7784	0.086	0.146
33	DTI	2,4-Dichlorophenoxyacetic acid, triisopropanolamine salt solution.	43	O	NA	III	N/A	.56-1(a), (b), (c), (g)	1.180	0.010	5.300	0.076	1.000	5001	5012	0.036	0.060
34	EAC	Ethyl acrylate	14	O	C	III	2	.50-70(a), .50-81(a), (b)	0.930	2.000	3.500	0.100	1.040	5200	5953	0.050	0.085
35	EAI	2-Ethylhexyl acrylate	14	O	E	III	2	.50-70(a), .50-81(a), (b)	0.890	0.015	6.350	0.077	1.000	5002	5018	0.036	0.061
36	EAN	Ethylamine solution (72% or less)	7	O	A	II	6	.55-1(b)	0.800	15.500	1.560	0.125	1.250	6250	8022	0.091	0.155
37	EBA	N-Ethylbutylamine	7	O	D	III	3	.55-1(b)	0.719	1.598	0.286	0.071	1.032	5160	4979	0.035	0.060
38	ECC	N-Ethylethelohexylamine	7	O	D	III	1	.55-1(b)	0.850	0.585	4.400	0.085	1.012	5059	5364	0.041	0.069
39	EDA	Ethylene diamine	7	O	D	III	1	.55-1(c)	0.910	0.900	2.100	0.081	1.018	5090	5247	0.039	0.066
40	EDC	Ethylene dichloride	36	O	C	III	1	No	1.260	4.000	3.420	0.122	1.080	5400	6831	0.066	0.112
41	EGC	Ethylene glycol monoalkyl ethers	40	O	D/E	III	1	No	0.970	0.200	4.720	0.080	1.004	5020	5138	0.037	0.064
42	EGH	Ethylene glycol hexyl ether	40	O	E	III	N/A	No	0.930	0.170	3.100	0.078	1.003	5017	5076	0.036	0.062
43	EGP	Ethylene glycol propyl ether	40	O	E	III	1	No	0.908	0.025	3.600	0.076	1.001	5003	5016	0.036	0.061
44	EPA	2-Ethyl-3-propylacrolein	19	O	E	III	1	No	0.850	0.120	4.350	0.078	1.002	5012	5062	0.036	0.062
45	ETC	Ethylene cyanohydrin	20	O	E	III	1	No	1.040	0.010	2.450	0.076	1.000	5001	5007	0.035	0.060
46	ETM	Ethyl methacrylate	14	O	D/E	III	2	.50-70(a)	0.920	1.000	3.940	0.090	1.020	5100	5548	0.044	0.074
47	GTA	Glutaraldehyde solution (50% or less)	19	O	NA	III	N/A	No	1.124	0.010	3.400	0.076	1.000	5001	5009	0.035	0.060

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	CHRIS CODE	NAME	COMP GROUP	SUB CHAP	GRADE	HULL TYPE	VCS CAT	REST.	LIQ SG	VAPOR PRESS	VAPOR SG	VAPOR AIR WEIGHT DENSITY	VAPOR GROWTH RATE	VAPOR FLOW RATE (bb/h)	AIR EQUIV FLOW RATE (bb/hr)	PRESSURE DROP TO PV VALVE IN VCS (LOADING) (psig)	PRESSURE DROP TO SHORE CONN IN VCS (LOADING)* (psig)
48	HMC	Hexamethylenediamine solution	7	O	E	III	1	.55-1(c)	1.210	10.500	1.260	0.089	1.210	6050	6545	0.061	0.103
49	HMI	Hexamethylenimine	7	O	C	II	1	.56-1(b), (c)	0.880	5.600	0.104	0.053	1.112	5560	4623	0.030	0.051
50	IAI	iso-Decl acrylate	14	O	E	III	2	.50-70(a), .50-81(a), (b), .55-1(c)	0.890	0.010	7.300	0.076	1.000	5001	5015	0.036	0.061
51	IPP	iso-Propylamine	7	O	A	II	5	.55-1(c)	0.690	23.100	2.030	0.243	1.250	6250	11172	0.177	0.300
52	IPR	Isoprene	30	O	A	III	7	.50-70(a), .50-81(a), (b)	0.672	11.300	1.772	0.117	1.226	6130	7609	0.082	0.139
53	KPL	Kraft pulping liquors (free alkali content 3% or more) (including: Black, Green, or White liquor)	5	O	NA	III	N/A	.50-73, .56-1(a), (c), (g)	0.800	10.060	2.960	0.169	1.201	6006	8950	0.113	0.193
54	MAM	Methyl acrylate	14	O	C	III	2	.50-70(a), .50-81(a), (b)	0.950	4.100	3.000	0.115	1.082	5410	6645	0.062	0.106
55	MCK	Methylcyclopentadiene dimer	30	O	C	III	1	No	0.941	0.040	0.930	0.076	1.001	5004	5008	0.035	0.060
56	MEA	Ethanamine	8	O	E	III	1	.55-1(c)	1.020	0.030	2.100	0.076	1.001	5003	5012	0.036	0.060
57	MEP	2-Methyl-5-ethylpyridine	9	O	E	III	1	.55-1(c)	0.920	0.160	4.180	0.079	1.003	5016	5098	0.037	0.063
58	MMM	Methyl methacrylate	14	O	C	III	2	.50-70(a), .50-81(a), (b)	0.940	2.020	3.450	0.099	1.040	5202	5948	0.050	0.085
59	MPA	iso-Propanolamine	8	O	E	III	1	.55-1(c)	0.960	0.080	2.590	0.077	1.002	5008	5032	0.036	0.061
60	MPL	Morpholine	7	O	D	III	1	.55-1(c)	1.000	0.800	3.000	0.084	1.016	5080	5329	0.040	0.068
61	MPR	2-Methylpyridine	9	O	D	III	3	.55-1(c)	0.940	2.065	3.200	0.097	1.041	5207	5896	0.049	0.084
62	MSO	Mesitol oxide	18	O	D	III	1	No	0.860	0.670	3.500	0.084	1.013	5067	5327	0.040	0.068
63	MSR	alpha-Methylstyrene	30	O	D	III	2	.50-70(a), .50-81(a), (b)	0.890	0.400	4.080	0.082	1.008	5040	5232	0.039	0.066
64	NCT	Coal tar naphtha solvent	33	O	D	III	1	.50-73	1.410	3.600	2.170	0.096	1.072	5360	6021	0.051	0.087
65	NPM	1- or 2-Nitropropane	42	O	D	III	1	.50-81	0.990	1.050	3.060	0.086	1.021	5105	5439	0.042	0.071
66	PAX	Propanolamine (iso-, n-)	8	O	E	III	1	.56-1(b), (c)	0.870	1.900	3.520	0.099	1.038	5190	5912	0.049	0.084
67	PDE	1,3-Pentadiene	30	O	A	III	7	.50-70(a), .50-81	0.680	17.060	2.360	0.209	1.250	6250	10352	0.152	0.258
68	PEB	Polyethylene polyamines	7	O	E	III	1	.55-1(c)	0.994	8.300	4.550	0.215	1.166	5830	9796	0.136	0.231
69	PER	Perchloroethylene	36	O	NA	III	N/A	No	1.620	1.230	5.830	0.104	1.025	5123	5994	0.051	0.086
70	PRD	Pyridine	9	O	C	III	1	.55-1(c)	0.980	1.300	2.720	0.087	1.026	5130	5477	0.042	0.072
71	SAU	Sodium aluminate solution (45% or less)	5	O	NA	III	N/A	.50-73, .56-1(a), (b), (c)	0.850	0.010	0.010	0.076	1.000	5001	5003	0.035	0.060
72	SDD	Sodium sulfide, hydrosulfide solution (H2S 15 ppm or less)	0	O	NA	III	N/A	.50-73	0.850	0.010	0.010	0.076	1.000	5001	5003	0.035	0.060
73	SSH	Sodium sulfide, hydrosulfide solution (H2S greater than 15 ppm but less than 200 ppm)	0	O	NA	III	1	.50-73, .55-1(b)	1.280	1.510	1.170	0.077	1.030	5151	5196	0.038	0.065
74	SSI	Sodium sulfide, hydrosulfide solution (H2S greater than 200 ppm)	0	O	NA	III	N/A	.50-73, .55-1(b)	1.280	1.510	1.170	0.077	1.030	5151	5196	0.038	0.065
75	SSJ	Sodium sulfide, hydrosulfidesolutions (H2S greater than 200ppm)	0	O	NA	II	N/A	.50-73, .55-1(b)	1.280	1.510	1.170	0.077	1.030	5151	5196	0.038	0.065
76	STY	Styrene monomer	30	O	D	III	2	.50-70(a), .50-81(a), (b)	0.920	0.400	3.600	0.081	1.008	5040	5203	0.038	0.065
77	TCB	1,2,4-Trichlorobenzene	36	O	E	III	1	No	1.450	0.010	6.260	0.076	1.000	5001	5013	0.036	0.061
78	TCL	Trichloroethylene	36	O	NA	III	1	No	1.470	3.500	4.540	0.134	1.070	5350	7113	0.072	0.122
79	TCM	1,1,2-Trichloroethane	36	O	NA	III	1	.50-73, .56-1(a)	1.430	0.010	4.550	0.076	1.000	5001	5010	0.036	0.060
80	TCN	1,2,3-Trichloropropane	36	O	E	II	3	.50-73, .56-1(a)	1.390	0.150	5.600	0.079	1.003	5015	5125	0.037	0.063
81	TEA	Triethanolamine	8	O	E	III	1	.55-1(b)	1.130	0.010	5.140	0.076	1.000	5001	5011	0.036	0.060
82	TEC	1,1,2,2-Tetrachloroethane	36	O	NA	III	N/A	No	1.600	1.000	5.800	0.099	1.020	5100	5811	0.048	0.081
83	TEN	Triethylamine	7	O	C	II	3	.55-1(c)	0.730	2.500	3.490	0.105	1.050	5250	6182	0.054	0.092
84	TET	Triethylenetetramine	7	O	E	III	1	.55-1(b)	0.980	0.010	5.040	0.076	1.000	5001	5011	0.036	0.060
85	THF	Tetrahydrofuran	41	O	C	III	1	.50-70(b)	0.890	8.500	1.350	0.090	1.170	5850	6370	0.057	0.098
86	TPB	Triphenylborane (10% or less), caustic soda solution	5	O	NA	III	N/A	.56-1(a), (b), (c)	0.870	1.500	3.140	0.091	1.030	5150	5642	0.045	0.077
87	UAS	Urea, Ammonium nitrate solution (containing more than 2% NH3)	6	O	NA	III	N/A	.56-1(b)	1.000	0.010	6.800	0.076	1.000	5001	5014	0.036	0.061
88	VAM	Vinyl acetate	13	O	C	III	2	.50-70(a), .50-81(a), (b)	0.940	5.800	2.970	0.130	1.116	5580	7293	0.075	0.128
89	VNT	Vinyltoluene	13	O	D	III	2	.50-70(a), .50-81, .56-1(a), (b), (c), (g)	0.900	0.120	4.080	0.078	1.002	5012	5073	0.036	0.062
90	ACP	Acetophenone	18	D	E	NA	1	NA	1.030	0.600	4.140	0.085	1.012	5060	5350	0.040	0.069
91	ACT	Acetone	18	D	C	NA	1	NA	0.790	10.000	2.000	0.123	1.200	6000	7636	0.082	0.140
92	BAL	Benzyl alcohol	21	D	E	NA	1	NA	1.050	0.100	3.730	0.077	1.002	5010	5056	0.036	0.062
93	BAN	Butyl alcohol (n-)	0	D	D	NA	1	NA	0.810	0.500	2.600	0.080	1.010	5050	5177	0.038	0.065

OWNER: Canal Barge Company

DESCRIPTION: Single Rake, Double Skin, Inland Tank Barge

SIZE: 297'-6"x54'-0"x12'-0"

HULL/NAME: 2207-1 Thru 4/CBC 313 - CBC 316

CONTRACT: 38201

BY: MEC

DATE: 1-Jul-2013

TABLE 1 - VAPOR CONTROL SYSTEM CALCULATIONS

	CHRIS CODE	NAME	COMP GROUP	SUB CHAP	GRADE	HULL TYPE	VCS CAT	REST.	LIQ SG	VAPOR PRESS	VAPOR SG	VAPOR AIR WEIGHT DENSITY	VAPOR GROWTH RATE	VAPOR FLOW RATE (bbl/hr)	AIR EQUIV FLOW RATE (bbl/hr)	PRESSURE DROP TO PV VALVE IN VCS (LOADING) (psig)	PRESSURE DROP TO SHORE CONN IN VCS (LOADING)* (psig)
94	BAS	Butyl alcohol (sec-)	0	D	C	NA	1	NA	0.810	1.300	2.600	0.086	1.026	5130	5454	0.042	0.072
95	BAT	Butyl alcohol (tert-)	0	D	C	NA	1	NA	0.780	2.800	2.600	0.097	1.056	5280	5970	0.050	0.086
96	BAX	Butyl acetate (all isomers)	34	D	D	NA	1	NA	0.870	0.600	4.000	0.085	1.012	5060	5338	0.040	0.069
97	BPH	Butyl benzyl phthalate	34	D	E	NA	1	NA	1.120	0.010	10.800	0.077	1.000	5001	5020	0.036	0.061
98	BUE	Butyl toluene	32	D	D	NA	1	NA	0.850	0.100	5.110	0.078	1.002	5010	5077	0.036	0.062
99	CHN	Cyclohexane	20	D	E	NA	1	NA	0.940	0.200	3.500	0.078	1.004	5020	5101	0.037	0.063
100	CHX	Cyclohexane	31	D	C	NA	1	NA	0.780	4.500	2.900	0.116	1.090	5450	6742	0.064	0.109
101	CLS	Caprolactam solutions	22	D	E	NA	1	NA	1.060	0.700	3.900	0.086	1.014	5070	5383	0.041	0.070
102	CMP	p-Cymene	32	D	D	NA	1	NA	0.860	0.460	4.620	0.084	1.009	5046	5303	0.040	0.068
103	DAA	Diacetone alcohol	20	D	E	NA	1	NA	0.940	0.100	4.000	0.078	1.002	5010	5060	0.036	0.062
104	DAX	Decyl alcohol (all isomers)	20	D	E	NA	1	NA	0.830	5.800	2.970	0.130	1.116	5580	7293	0.075	0.128
105	DBL	Diisobutylene	30	D	C	NA	1	NA	0.720	2.200	3.970	0.107	1.044	5220	6189	0.054	0.092
106	DCE	Decene	30	D	D	NA	1	NA	0.740	0.120	5.300	0.079	1.002	5012	5095	0.037	0.063
107	DOB	Dodecylbenzene; see Alkyl(C9+)benzenes	32	D	E	NA	1	NA	0.860	4.700	8.400	0.240	1.094	5470	9711	0.133	0.227
108	DDO	Diphenyl, Diphenyl ether mixtures	33	D	E	NA	1	NA	1.070	0.010	5.870	0.076	1.000	5001	5012	0.036	0.060
109	DEB	Diethylbenzene	32	D	D	NA	1	NA	0.870	0.080	4.620	0.078	1.002	5008	5057	0.036	0.062
110	DEG	Diethylene glycol	40	D	E	NA	1	NA	1.120	0.010	3.660	0.076	1.000	5001	5009	0.035	0.060
111	DIK	Diisobutyl ketone	18	D	D	NA	1	NA	0.810	0.480	4.900	0.085	1.010	5048	5336	0.040	0.069
112	DOP	Dioctyl phthalate	34	D	E	NA	1	NA	0.990	0.010	13.450	0.077	1.000	5001	5024	0.036	0.061
113	DPG	Dipropylene glycol	40	D	E	NA	1	NA	1.030	0.070	4.630	0.077	1.001	5007	5050	0.036	0.061
114	EAL	Ethyl alcohol	20	D	C	NA	1	NA	0.790	3.500	1.600	0.086	1.070	5350	5691	0.046	0.078
115	EBT	Ethyl butanol	20	D	D	NA	1	NA	0.830	0.140	3.400	0.078	1.003	5014	5070	0.036	0.062
116	EGL	Ethylene glycol	20	D	E	NA	1	NA	1.130	0.010	2.210	0.076	1.000	5001	5007	0.035	0.060
117	EGY	Ethylene glycol diacetate	34	D	E	NA	1	NA	1.130	0.010	1.000	0.076	1.000	5001	5005	0.035	0.060
118	EHX	2-Ethylhexanol	20	D	E	NA	1	NA	0.830	0.015	4.500	0.076	1.000	5002	5014	0.036	0.061
119	ETA	Ethyl acetate	34	D	C	NA	1	NA	0.900	4.500	3.040	0.119	1.090	5450	6827	0.066	0.112
120	ETB	Ethylbenzene	32	D	C	NA	1	NA	0.870	0.600	3.660	0.084	1.012	5060	5308	0.040	0.068
121	ETG	Ethoxy triglycol (crude)	40	D	E	NA	1	NA	1.020	0.010	6.140	0.076	1.000	5001	5013	0.036	0.060
122	FAL	Furfuryl alcohol	20	D	E	NA	1	NA	1.290	0.100	3.370	0.077	1.002	5010	5050	0.036	0.061
123	GAT	Gasolines: Automotive (containing not over 4.23 grams lead per gallon)	33	D	C	NA	1	NA	0.760	12.500	3.400	0.217	1.250	6250	10563	0.158	0.269
124	GCR	Glycerine	20	D	E	NA	1	NA	1.260	0.010	3.170	0.076	1.000	5001	5008	0.035	0.060
125	HMX	Heptane (all isomers), see Alkanes (C6-C9) (all isomers)	31	D	C	NA	1	NA	0.680	2.500	3.450	0.105	1.050	5250	6168	0.054	0.092
126	HXG	Hexylene glycol	20	D	E	NA	1	NA	0.920	0.010	4.000	0.076	1.000	5001	5010	0.036	0.060
127	HXN	Hexanol	20	D	D	NA	1	NA	0.820	1.000	3.520	0.088	1.020	5100	5487	0.043	0.072
128	IAC	iso-Propyl acetate	34	D	C	NA	1	NA	0.880	3.100	3.520	0.113	1.062	5310	6470	0.059	0.101
129	IAL	Butyl alcohol (iso-)	20	D	D	NA	1	NA	0.810	0.900	2.600	0.083	1.018	5090	5316	0.040	0.068
130	IDA	Iso-Decaldehyde	19	D	E	NA	1	NA	0.830	0.060	5.380	0.077	1.001	5006	5050	0.036	0.061
131	IPA	iso-Propyl alcohol	20	D	C	NA	1	NA	0.790	3.000	2.070	0.091	1.060	5300	5806	0.048	0.081
132	IPH	Isophorone	18	D	E	NA	1	NA	0.930	0.010	4.750	0.076	1.000	5001	5011	0.036	0.060
133	KRS	Kerosene	33	D	D	NA	1	NA	0.810	0.150	4.500	0.079	1.003	5015	5100	0.037	0.063
134	MAC	Methylamyl acetate	34	D	D	NA	1	NA	0.860	0.340	5.000	0.083	1.007	5034	5245	0.039	0.066
135	MAL	Methyl alcohol	20	D	C	NA	1	NA	0.790	7.000	1.100	0.079	1.140	5700	5826	0.048	0.082
136	MBE	Methyl tert-butyl ether	41	D	C	NA	1	NA	0.740	0.040	3.100	0.077	1.001	5004	5021	0.036	0.061
137	MEK	Methyl ethyl ketone	18	D	C	NA	1	NA	0.800	4.500	2.500	0.108	1.090	5450	6492	0.060	0.101
138	MIK	Methyl isobutyl ketone	18	D	C	NA	1	NA	0.800	1.200	3.450	0.090	1.024	5120	5570	0.044	0.075
139	MNS	Mineral spirits	33	D	D	NA	1	NA	0.750	0.200	4.300	0.079	1.004	5020	5125	0.037	0.063
140	MTT	Methyl acetate	34	D	D	NA	1	NA	0.920	6.100	2.600	0.122	1.122	5610	7107	0.071	0.122
141	NNP	Nonyl phenol	21	D	E	NA	1	NA	0.940	0.010	7.590	0.076	1.000	5001	5015	0.036	0.061
142	NSS	Naphtha: Stoddard solvent	33	D	D	NA	1	NA	0.780	0.200	0.010	0.075	1.004	5020	4993	0.035	0.060
143	NSV	Naphtha: Solvent	33	D	D	NA	1	NA	0.870	0.200	3.500	0.078	1.004	5020	5101	0.037	0.063
144	NVM	Naphtha: Varnish makers and painters (75%)	33	D	C	NA	1	NA	0.770	0.190	0.010	0.075	1.004	5019	4994	0.035	0.060
145	ODS	Oil, misc: Diesel	33	D	DE	NA	1	NA	0.900	5.800	2.970	0.130	1.116	5580	7293	0.075	0.128

OWNER: Canal Barge Company

DESCRIPTION: Single Rake, Double Skin, Inland Tank Barge

SIZE: 297'-6"x54'-0"x12'-0"

HULL/NAME: 2207-1 Thru 4/CBC 313 - CBC 316

CONTRACT: 38201

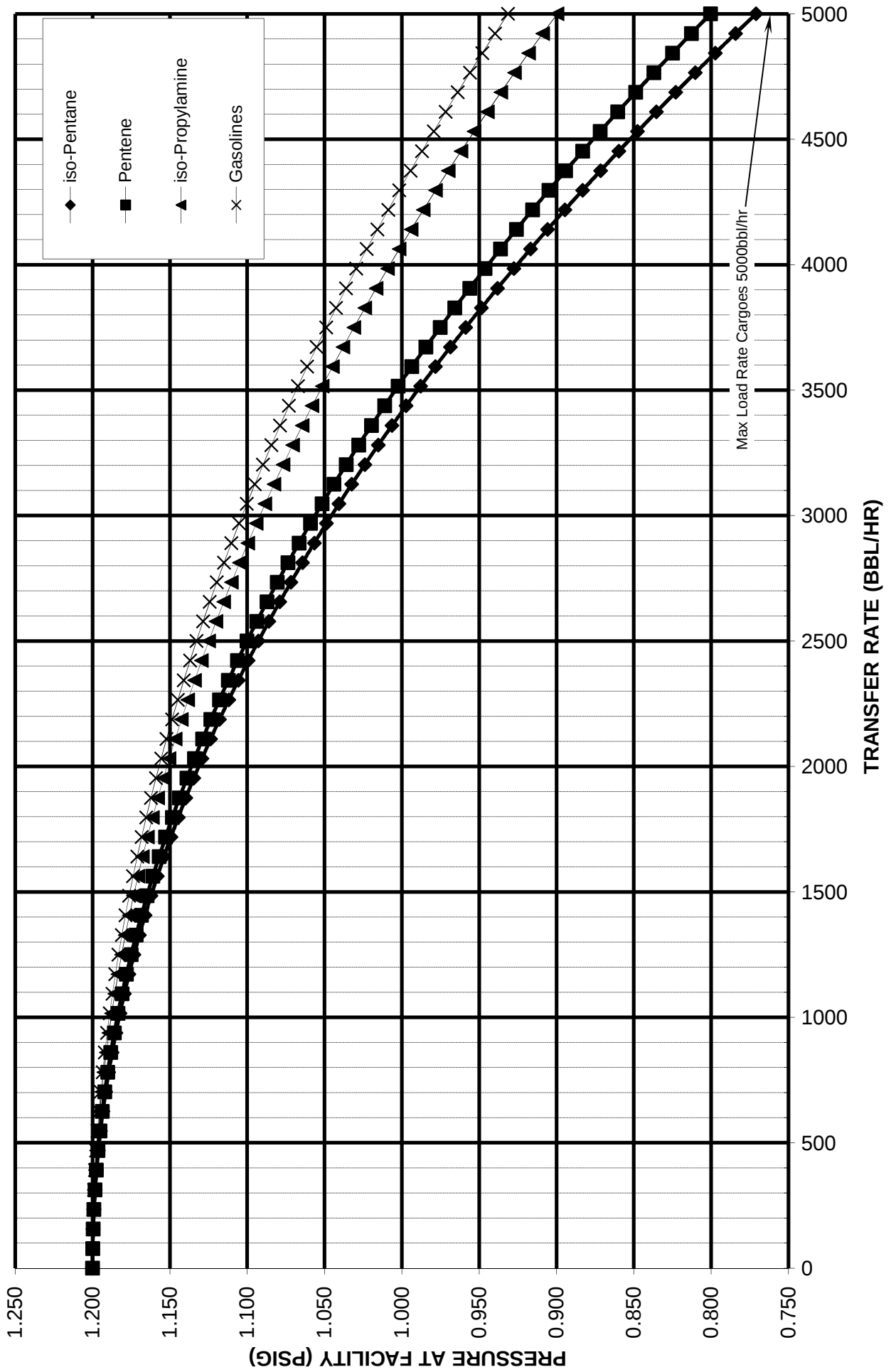
BY: MEC

DATE: 1-Jul-2013

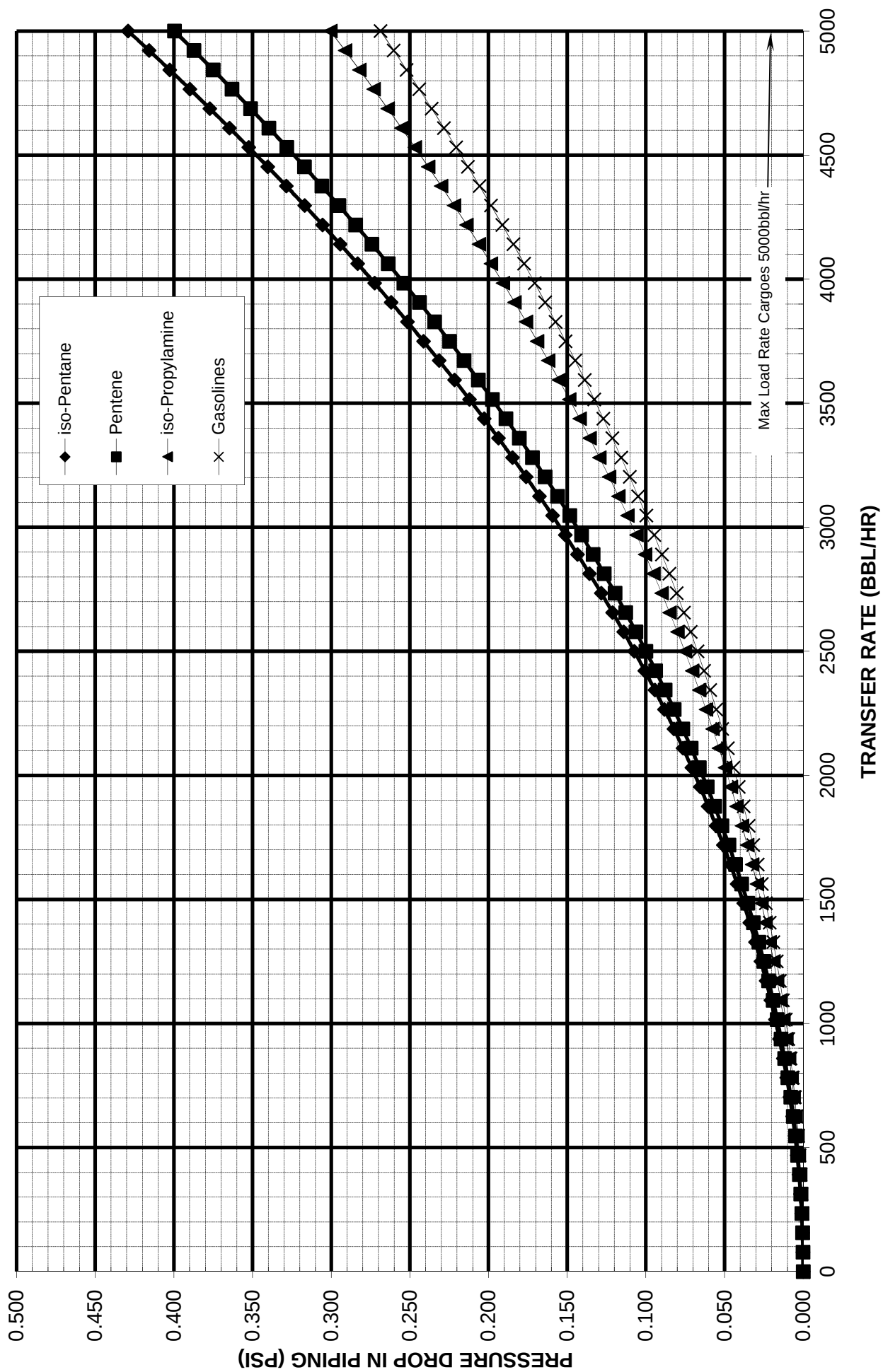
TABLE 1 - VAPOR CONTROL SYSTEM CALCULATIONS

	CHRIS CODE	NAME	COMP GROUP	SUB CHAP	GRADE	HULL TYPE	VCS CAT	REST.	LIQ SG	VAPOR PRESS	VAPOR SG	VAPOR AIR WEIGHT DENSITY	VAPOR GROWTH RATE	VAPOR FLOW RATE (bb/h)	AIR EQUIV FLOW RATE (bb/hr)	PRESSURE DROP TO PW VALVE IN VCS (LOADING)* (psig)	PRESSURE DROP TO SHORE CONN IN VCS (LOADING)* (psig)
146	OIL	Oil, misc: Crude	33	D	C/D	NA	1	NA	0.950	5.800	2.970	0.130	1.116	5580	7293	0.075	0.128
147	OSX	Oil, fuel: No. 6	33	D	E	NA	1	NA	0.950	0.149	2.970	0.078	1.003	5015	5064	0.036	0.062
148	OTW	Oil, fuel: No. 2	33	D	D/E	NA	1	NA	0.880	0.560	8.000	0.095	1.011	5056	5639	0.045	0.077
149	PAL	n-Propyl alcohol	20	D	C	NA	1	NA	0.800	1.200	2.070	0.082	1.024	5120	5323	0.040	0.068
150	PAT	n-Propyl acetate	34	D	C	NA	1	NA	0.870	1.900	3.520	0.099	1.038	5190	5912	0.049	0.084
151	PBY	Propylbenzene (all isomers)	32	D	D	NA	1	NA	0.860	0.600	4.200	0.085	1.012	5060	5356	0.041	0.069
152	PLB	Polybutene	30	D	E	NA	1	NA	0.910	0.010	0.010	0.076	1.000	5001	5003	0.035	0.060
153	PTE	Pentene (all isomers)	31	D	A	III	5	NA	0.637	24.945	2.500	0.323	1.250	6250	12883	0.235	0.400
154	PTY	iso-Pentane	30	D	A	III	5	NA	0.620	27.000	2.480	0.347	1.250	6250	13350	0.252	0.429
156	TCP	Tricresyl phosphate (less than 1% of the ortho isomer)	34	D	E	NA	1	NA	1.170	0.010	12.700	0.077	1.000	5001	5023	0.036	0.061
155	TEB	Triethylbenzene	32	D	E	NA	1	NA	0.860	0.050	5.600	0.077	1.001	5005	5044	0.036	0.061
157	TEG	Triethylene glycol	40	D	E	NA	1	NA	1.120	0.010	5.170	0.076	1.000	5001	5011	0.036	0.060
158	THN	Tetrahydronaphthalene	32	D	E	NA	1	NA	0.980	0.040	4.550	0.077	1.001	5004	5030	0.036	0.061
159	TOL	Toluene	32	D	C	NA	1	NA	0.870	1.500	3.140	0.091	1.030	5150	5642	0.045	0.077
160	TTG	Tetraethylene glycol	40	D	E	NA	1	NA	1.130	0.010	6.700	0.076	1.000	5001	5014	0.036	0.061
Max Vapor Density Cargo		PTY iso-Pentane	30	D	A	III	5	NA	0.620	27.000	2.480	0.347	1.250	6250	13350	0.252	0.429
Max Pressure Drop Cargo		PTY iso-Pentane	30	D	A	III	5	NA	0.620	27.000	2.480	0.347	1.250	6250	13350	0.252	0.429

LIQUID TRANSFER RATE vs FACILITY PRESSURE BASED ON PRESSURE DROP FROM CARGO TANK #1 TO FACILITY CONNECTION WITH DUAL LOADING



LIQUID TRANSFER RATE vs PIPING PRESSURE DROP CARGO TANK #1 TO FACILITY CONNECTION WITH DUAL LOADING





Marine Safety Center Form for Tank Vessels Installing a Vapor Control System



1. Vessel Name _____
Official Number _____

Shipyard _____
Hull # _____

2. **Purpose:** This form consolidates the information required for VCS approval. Entering the requested information will expedite your approval and significantly decrease the probability the MSC will return the submission for revision.

3. **Tank Design:** Raised Trunk ☐ Maximum Design Working Pressure: _____ psig
Flush Deck ☐ Existing Raised Trunk Barges need MSC approval letter serial number and date which approved its MDWP _____

4. **Requested Maximum Cargo Transfer Rates** _____ bbl/hr loading
_____ bbl/hr discharging

5. **Requested Maximum Cargo-Air Mixture Vapor Density:**

List the requested cargoes with the (a) highest vapor density and (b) highest pressure drop. They are not always the same cargo.

a. Cargo Name _____ lbm/ft³
b. Cargo Name _____ lbm/ft³

6. **VCS Categories Requested (list):** _____

7. **Pressure Drop for the cargo(es) from Section 5 for the following scenarios:**

	Cargo A psi	Cargo B psi
a. Most Remote Cargo Tank to P/V valve		
b. Most Remote Cargo Tank to VCS Facility Connection		
c. ΔP across P/V valve @ cargoes' Maximum Transfer Rate		
d. ΔP across Vacuum P/V @ MTR or Max. Discharge Rate		
e. ΔP across Spill Valve for Max. Density Cargo at MTR		

8. **Pressure Vacuum Valve:**

Manufacturer _____
Model/Size _____
CG Approval Number _____

Settings in psig:
Pressure-side _____
Vacuum-side _____

Include the Manufacturer's ΔP versus Flow for both parts of P/V & Spill Valve: ☐

9. **VCS Pipe Sizes:**

Longitudinal Header _____ Inches Transverse Headers _____ Inches

10. **Closed Gauging** ☐

Check the box to signify the vessel will have closed gauging meeting 46 CFR 151.151-10(c). MSC Electrical Branch and the OCMI will verify the closed gauging meets these requirements.

11. **Tank Overfill Protection System** (check appropriate box or boxes and list make/model)

a. High Level/Tank Overfill Alarm	☐		Setting in psig	_____
b. Overfill Control Shutdown	☐			
c. Spill Valve	☐		Meets ASTM F1271	☐
d. Rupture Disk	☐			

If applicable, Calculations demonstrate compliance with 39.20-9(b)(2). ☐

12. Submittal Includes a Graph or Table showing the ΔP through the VCS piping from the most remote cargo tank to the facility connection as a function of liquid transfer rate for **both** cargoes in Section 5. ☐

13. Submittal Includes a Graph or Table showing the Facility Pressure @ the vessel's vapor connect versus allowable transfer rate. This graph demonstrates the barge can satisfy 46 CFR 39.30-1(d)(3). See MSC "Guidelines" at www.msc.uscg/hq/msc for an example. ☐

14. Previous VCS approval letters: _____

PORT TANKS SHOWN STBD TANK SIMILAR

TANK LIST

		Reference Point		
Part-----	Type-----	Long---	Trans----	Vert
CT1.P	INTACT TANK	75.12a	11.04p	17.08
CT2.P	INTACT TANK	159.87a	11.04p	17.08
CT3.P	INTACT TANK	247.62a	11.04p	17.08
Distances in FEET.....				

FULL LOAD TANKS AT 100%

TANK STATUS

Trim: zero, Heel: zero

Part-----	BBLs-----	SpGr-----	Weight(ST)-----	LCG-----	TCG-----	VCG-----	RefHt
CT1.P	5240.7	1.050	964.37	75.95a	11.86p	9.45	
CT2.P	5120.4	1.050	942.23	161.77a	11.86p	9.37	
CT3.P	4910.9	1.050	903.68	245.37a	11.84p	8.98	
Total Tanks----->			2,810.28	159.21a	11.85p	9.27	
Distances in FEET.....							

HIGH LEVEL SETPOINT AT 0.95 OF FULL LOAD 46CFR39.20-7(c)(1)

TANK STATUS

Trim: zero, Heel: zero

Part-----	BBLs-----	SpGr-----	Weight(ST)-----	LCG-----	TCG-----	VCG-----	RefHt
CT1.P	4978.7	1.050	916.15	75.96a	11.93p	9.10	1.27
CT2.P	4864.3	1.050	895.12	161.75a	11.93p	9.01	1.28
CT3.P	4664.6	1.050	858.35	245.80a	11.90p	8.61	1.46
Total Tanks----->			2,669.62	159.33a	11.92p	8.91	
Distances in FEET.....							

OVERFILL SETPOINT BASED ON 0.985 OF FULL LOAD 46CFR39.30-1(e)(1)

TANK STATUS

Trim: zero, Heel: zero

Part-----	BBLs-----	SpGr-----	Weight(ST)-----	LCG-----	TCG-----	VCG-----	RefHt
CT1.P	5162.0	1.050	949.89	75.94a	11.93p	9.34	0.77
CT2.P	5043.5	1.050	928.08	161.75a	11.93p	9.26	0.77
CT3.P	4836.5	1.050	890.00	245.51a	11.90p	8.87	0.85
Total Tanks----->			2,767.97	159.24a	11.92p	9.16	
Distances in FEET.....							

OVERFILL SETPOINT BASED ON 60SEC AT 5000BBL/HR 46CFR39.20-9(b)(2)

TANK STATUS

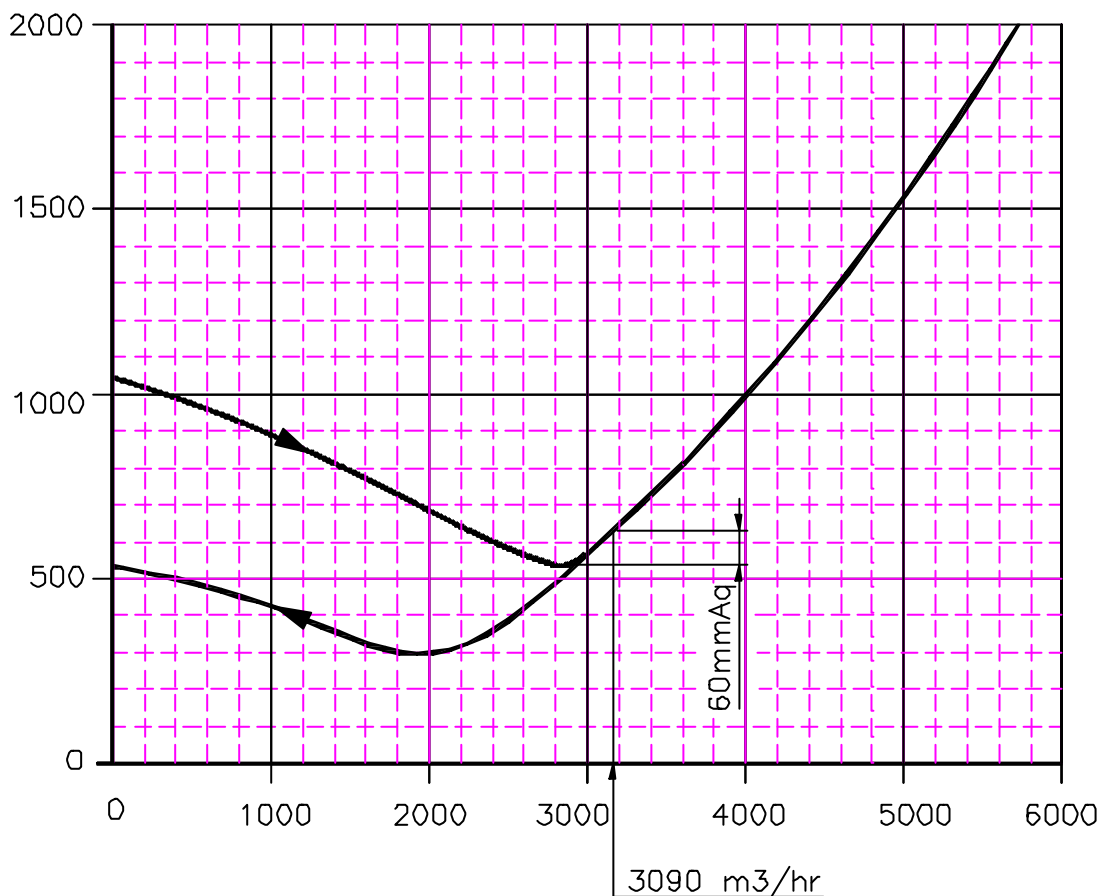
Trim: zero, Heel: zero

Part-----	BBLs-----	SpGr-----	Weight(ST)-----	LCG-----	TCG-----	VCG-----	RefHt
CT1.P	5157.3	1.050	949.03	75.94a	11.93p	9.34	0.78
CT2.P	5037.0	1.050	926.89	161.75a	11.93p	9.25	0.79
CT3.P	4827.0	1.050	888.25	245.52a	11.90p	8.86	0.88
Total Tanks----->			2,764.17	159.21a	11.92p	9.15	
Distances in FEET.....							

HIGH VELOCITY VENT VALVE FLOW CAPACITY CURVE

MODEL : KSPA-6
 SIZE : 6"(150A)
 SETTING PRESSURE : 1050 m m Aq

VALVE INLET PRESSURE, m m Aq
 (1 m m Aq = 0.0014286PSI)

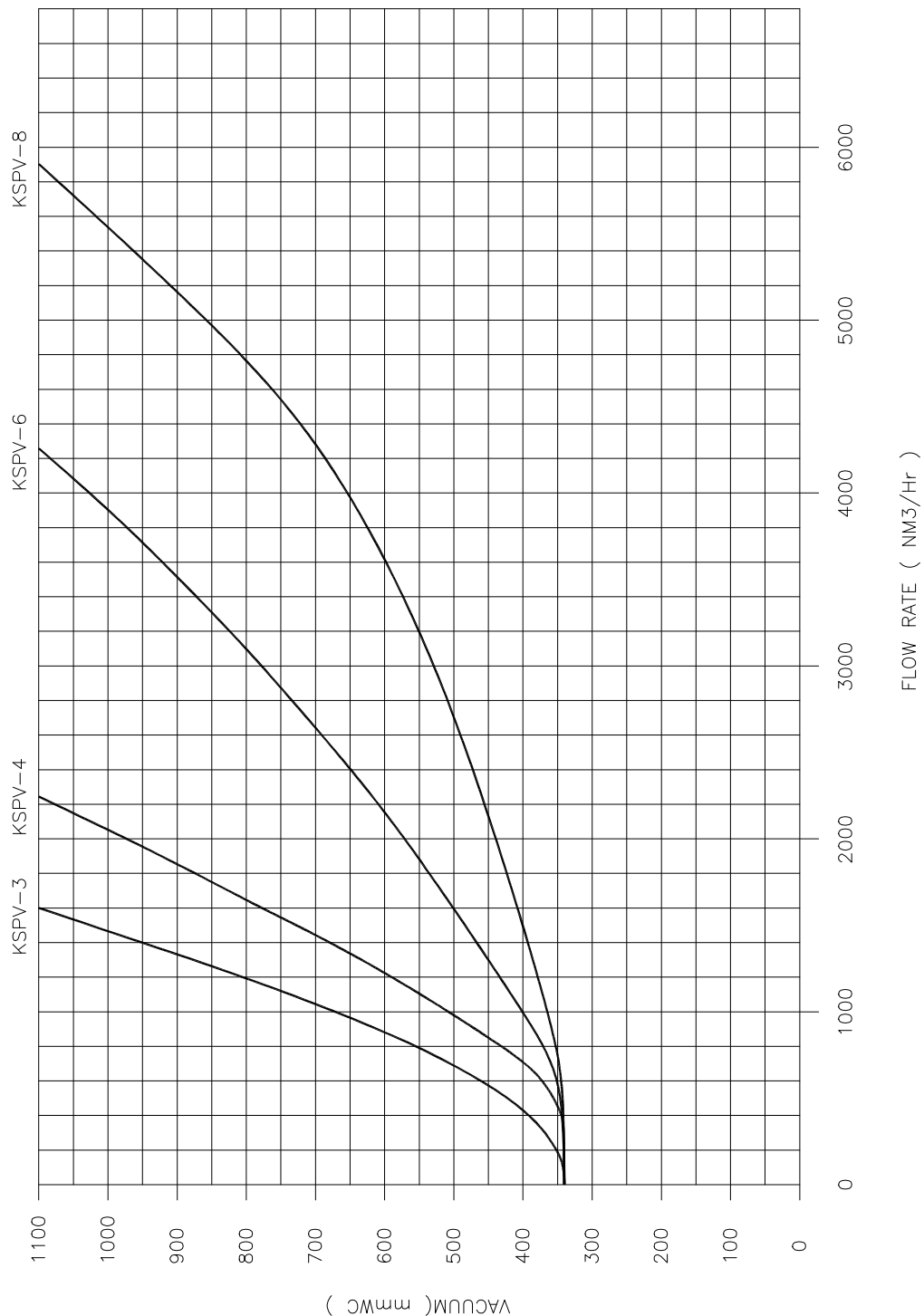


FLOW CAPACITY CURVE, SCMH(Standard cubic meter per hour)
 (1SCMH = 6.289BBL/hr)

APPLICABLE STANDARD	TEST CONDITION	SHEET NO. 1/1
IMO MSC/Circ.677 API Standard 2000	FLOW TEST PERFORMED ON EQUIPMENT USING AIR, AT TEMP.T=15.6 AND AMBIENT PRESSURE P=1.0332Kg/cm ²	

FLOW CAPACITY CURVE GRAPH

FLOW TEST PERFORMED ON EQUIPMENT
USING AIR, AT TEMP. T=15.6°C AND
AMBIENT PRESSURE P=1.0332 KG/CM2.



TANKTECH

TITLE *HIGH VELOCITY VACUUM RELIEF VALVE*

KSPV TYPE