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217' x 42' ACETIC ACID TANK BARGE

VAPOR CONTROL SYSTEM CALCULATIONS
GC,LLC Dwg No. C-32

GC, LLC Job No. 07-024

Conrad Shipyard, LLC Hulls 801, 802

Rev. 0

25-Sep-07

I. VAPOR CONTROL SYSTEM CALCULATIONS - SUMMARY

A. General Description of Vessel:

Builder:	CONRAD SHIPYARD, INC	
Builder's hull numbers:	Conrad Hulls 801, 802	
Year Built:	2007	
Official Numbers:	TBD	
Owner:	Blessey Marine Services	
Vessel Names:	WEB 180S, WEB 181S	
Vessel Dimensions:	217' x 42' x 10'	
Service:	Tank Barge (D/O)	
Classification:	ABS	
Max Design Working Pressure of Tanks:	3.0	(psig)
Max Cargo Loading Rate (Gasoline & lower): (when loading two or more tanks simultaneously)	4,800	(bbl/hr)
Max Cargo Loading Rate (Gasoline & lower): (when loading one tank at a time)	2,400	(bbl/hr)
Max Discharge Rate (per pump):	1,344	(gpm)
Max Discharge Rate (per pump):	1,920	(bbl/hr)
Number of Cargo Pumps:	1	
Maximum Discharge Rate (total):	1,920	(bbl/hr)
VCS Cargoes:	See Table 1	
Maximum Vapor-Air Mixture Density:	0.219	(lbm/ft^3)
Maximum Vapor Growth Rate:	1.25 (for Gasoline & lower cargoes)	(lbm/ft^3)

B. General Description of Vapor Control System:

[Note: Also see Reference 6 for details of vapor control system.]

1. Pipe:

One (1) 8" diam longitudinal vapor header fitted with a 6" high-velocity PV Valve.
One (1) 8" diam tranverse vapor header with 8" shore connection valves.
One (1) 8" diam branch line off longitudinal header to each expansion trunk.
(See Reference 6 for system layout)

2. High Velocity PV Valve:

Model:	Tanktech U-ISO-HV-150	
Pressure Setting:	2.00	(psig)
Vacuum Setting:	0.5	(psig)
PV Valve Flow Capacity:	See Att. 1	(bbl/hr)

3. Spill Valve:

Model:	None installed
Pressure Setting:	N/A

4. Vapor Recovery Hose:

Diameter:	Vapor hose not carried
Length:	n/a

5. Cargo Tank P-V Valves: (One central P/V valve only, no individual tank P-V valves)

Model:	Tanktech U-ISO-HV-150	
Pressure Setting:	2.00	(psig)
Vacuum Setting:	0.5	(psig)

C. VCS Calculations:

1. **Cargo Authority:**
   The vapor collection system installed on this barge is designed for Grade A and lower petroleum products and acetic acid. Typical cargoes to be carried by this barge are listed in Table 1. These cargoes are to be listed on the barge's Certificate of Inspection.

2. **Determining Vapor-Air Mixture Density and Vapor Growth Rate:**
   Of the cargoes carried, Gasoline has the highest vapor-air mixture density. Gasoline also has the greatest vapor growth rate. (See Table 1)

3. **The Maximum Liquid Transfer Rate as Imposed by the Capacity of the Cargo Tank Venting System: (Ref: 46 CFR 39.20-11)**

   Tanks #1S and #1P are the farthest tanks from the High-Velocity P-V Valve in terms of total equivalent pipe length. Using factors from Reference 4 and 9, the total equivalent length of pipe is calculated for this path. This calculation is shown in Table 2.

   Using Darcy's equation, and friction factors selected as appropriate for the pipe size, and the maximum liquid transfer rate, the pressure drop along the VCS piping from tanks #1S and #1P to the P-V Valve is calculated using the total equivalent length of pipe from Table 2. The pressure drop calculations were done for the maximum loading rate (4,800 BBL/hr) for this barge. This maximum loading rate is based on loading at least two (2) tanks at a time. The maximum loading rate per tank is 2,400 bbl/hr (1/2 of the maximum loading rate for this barge). This calculation is shown in Table 3.

   Conclusions:
   Using a 4,800 bbl/hr maximum liquid transfer rate (for Gasoline and lower cargos), the vapor-air mixture and air-equivalent volumetric flow rates for each cargo are shown in Table 3. The greatest pressure drop in the cargo tank venting system is 0.104 psig for Gasoline cargo. At a pressure relief setting of 2 psig, the high-velocity P-V valve has an adequate flow capacity (see attachment 1). The greatest total back pressure imposed on the tanks by the cargo tank venting system (2.44 psig) does not exceeed the design working pressure of the cargo tanks (3.0 psig). Also, the vacuum relieving capacity of the P-V Valve has been checked against the maximum discharge rate and has been found to have adequate vacuum relieving capacity (see Table 3).

4. **The Maximum Liquid Transfer Rate as Imposed by the Relieving Capacity of the Cargo Tank Spill Valves:**
   No spill valves are installed on this barge.

5. **The Maximum Liquid Transfer Rate as Imposed by the Set Point of the Overfill Alarm:**
   At the maximum cargo loading rate of 4,800 bbl/hr, required overfill alarm set points have been calculated such that the person in charge of the transfer operations has more than 60 seconds from the overfill alarm to stop the transfer operations before the tank overflows. (See attached overfill alarm set point calculation sheets.) The overfill alarms will need to be set at or below these calculated levels to ensure that the VCS complies with 46 CFR 39.20-9. In addition, the overfill alarms must also be set at or below a capacity of 98.5% to comply with 33CFR155.775.

6. **The Maximum Liquid Transfer Rate as imposed by the pressure drop between the most remote tank and the facility vapor connection (Ref: 46 CFR 39.30-1(d)(3):**
   This requires the sum of the pressure drop along the longest path from the cargo tank to the vessel vapor connection and the back pressure at the facility vapor connection not to exceed 80 percent of the pressure setting of any pressure relief valve in the system. Tanks #2S and #2P are the farthest from the facility vapor connection (in terms of total equivalent length of pipe). The total equivalent length from cargo tanks #2S and #2P to the facility vapor connection is given in Table 4.

   Using Darcy's equation, and friction factors selected as appropriate for the pipe size, and the maximum liquid transfer rate, the pressure drop along the VCS piping from tanks #2S and #2P to the facility vapor connection is calculated using the total equivalent length of pipe from Table 4. These calculations are shown in Table 5.

   Conclusions:
   Pressure drop at the maximum liquid transfer rate of 4,800 bbl/hr (for Gasoline and lower cargoes) along this path for each cargo is given in Table 5. The highest pressure drop (for Gasoline) does not exceed 80 percent of the P-V valve pressure setting (1.60 psig). If the pressure drop between the facility vapor connection and the shore facility's pressure sensor is known, it should be added to the pressure drop along this path to ensure that the total pressure drop does not exceed 80 percent of the P-V valve pressure setting.

7. **Graph as Required by 46 CFR 39.30-1(b)(3):**
   See attached.

Table 1 **Determination of Vapor-Air Mixture Density & Vapor Growth Rate**

	CHRIS Code	Name	VCS Category	Liquid S.G.	*Vapor Press. @ 115 F (psia)	Vapor S.G.	Vapor-air Mixture Weight Density (lb/ft^3)	Vapor Growth Rate	Max. Loading Rate	Vapor Volumetric Flow Rate (bbl/hr)	Air Equivalent Volumetric Flow Rate (bbl/hr)	Pressure Drop to PV Valve in VCS (See Table 3) (psig)	Pressure Drop to Facility Connection in VCS (See Table 5) (psig)
1	AAC	Acetic Acid	1	1.050	0.92	2.07	0.083	1.02	4,800	4888	5030	0.026	0.025
2	DFF	Distillates: Flashed Feed Stocks	1	0.750	2.36	3.39	0.105	1.05	4,800	5027	5814	0.035	0.033
3	DSR	Distillates: Straight Run	1	0.731	2.36	3.40	0.105	1.05	4,800	5027	5817	0.035	0.033
4	GAK	Gasoline blending stocks: Alkylates	1	0.750	12.50	3.40	0.219	1.25	4,800	6000	10033	0.104	0.099
5	GAT	Gasoline: Automotive	1	0.732	12.50	3.40	0.219	1.25	4,800	6000	10033	0.104	0.099
6	GAV	Gasoline: Aviation	1	0.711	12.50	3.40	0.219	1.25	4,800	6000	10033	0.104	0.099
7	GRF	Gasoline blending stocks: Reformates	1	0.793	12.50	3.40	0.219	1.25	4,800	6000	10033	0.104	0.099
8	GSR	Gasoline: Straight Run	1	0.747	12.50	3.40	0.219	1.25	4,800	6000	10033	0.104	0.099
9	JPF	Jet Fuels: JP-4	1	0.810	3.48	4.50	0.136	1.07	4,800	5134	6749	0.047	0.045
10	JPO	Jet Fuels: JP-1	1	0.800	0.15	3.40	0.080	1.00	4,800	4814	4866	0.024	0.023
11	JPT	Jet Fuels: JP-3	1	0.800	8.50	3.40	0.174	1.17	4,800	5616	8371	0.072	0.069
12	JPV	Jet Fuels: JP-5	1	0.820	0.10	4.50	0.080	1.00	4,800	4810	4860	0.024	0.023
13	KRS	Kerosene	1	0.800	0.15	4.50	0.081	1.00	4,800	4814	4889	0.025	0.023
14	MNS	Mineral Spirits	1	0.780	0.19	5.00	0.082	1.00	4,800	4818	4925	0.025	0.024
15	NCT	Naphtha: Coal Tar	1	0.880	0.19	3.40	0.081	1.00	4,800	4818	4882	0.025	0.023
16	NSS	Naphtha: Stoddard Solvent	1	0.780	0.19	4.30	0.081	1.00	4,800	4818	4906	0.025	0.024
17	NSV	Naphtha: Solvent	1	0.870	0.19	3.50	0.081	1.00	4,800	4818	4885	0.025	0.023
18	NVM	Naphtha: VM & P	1	0.750	0.19	4.30	0.081	1.00	4,800	4818	4906	0.025	0.024
19	ODS	Oils: Diesel	1	0.841	0.15	4.50	0.081	1.00	4,800	4814	4889	0.025	0.023
20	OFR	Oils, Fuel: 4	1	0.904	0.15	3.40	0.080	1.00	4,800	4814	4866	0.024	0.023
21	OFV	Oils, Fuel: 5	1	0.936	0.15	3.40	0.080	1.00	4,800	4814	4866	0.024	0.023
22	OLB	Oils, Misc: Lubricating	1	0.902	0.15	3.40	0.080	1.00	4,800	4814	4866	0.024	0.023
23	OMT	Oils, Misc: Motor	1	0.960	0.15	3.40	0.080	1.00	4,800	4814	4866	0.024	0.023
24	OOD	Oils, Fuel: 1-D	1	0.850	0.15	3.40	0.080	1.00	4,800	4814	4866	0.024	0.023
25	OON	Oils, Fuel: No. 1	1	0.850	0.15	3.40	0.080	1.00	4,800	4814	4866	0.024	0.023
26	ORG	Oils, Misc: Range	1	0.850	0.15	3.40	0.080	1.00	4,800	4814	4866	0.024	0.023
27	OSX	Oils, Fuel: No. 6	1	0.950	0.15	3.40	0.080	1.00	4,800	4814	4866	0.024	0.023
28	OTD	Oils, Fuel: 2-D	1	0.900	0.69	3.40	0.086	1.01	4,800	4866	5101	0.027	0.025
29	OTW	Oils, Fuel: 2	1	0.879	0.56	8.00	0.097	1.01	4,800	4854	5391	0.030	0.028
						max =	0.219	1.25			max =	0.104	0.099

Notes: 1. The above data is sourced from the USCG CHRIS Manual (Ref. 7) & from various manufacturer's MSDS's.

Table 2 **Calculation of Maximum Liquid Transfer Rate as Imposed by the Capacity of the Cargo Tank Venting System**

Note: Darcy's equation will be used to estimate the pressure drop of the vapor-air mixture through the vent piping from the farthest tank in terms of equivalent pipe length (#1S and #1P) to the P-V valve. Equivalent length for this path is calculated using Crane's Technical Paper 410 (Ref 4) and Cameron Hydraulic Data handbook (Ref 9).

Calculate equivalent lengths of pipe:

a. Pipe run #1

Description: 8" Branch (Exp trunk to vapor header)
Pipe size, nominal: 8" sch. 40 pipe
Pipe ID (inches): 7.98

Item	Description	Size (in)	Qty	Unit Equivalent Length (ft)	Total Equivalent Length (ft)
1	Entrance	8	1	23.3	23.3
2	Straight Pipe	8	1	1.9	1.9
3	Tee, branch	8	1	39.9	39.9
	Sum (pipe run #1)				65.0

b. Pipe run #2

Description: 8" Vapor header to PV Valve Branch
Pipe size, nominal: 8" sch. 40 pipe
Pipe ID (inches): 7.98

Item	Description	Size (in)	Qty	Unit Equivalent Length (ft)	Total Equivalent Length (ft)
1	Straight Pipe	8	1	68.8	68.8
2	Tee, run	8	1	13.3	13.3
	Sum (pipe run #2)				82.1

c. Pipe run #3

Description: 6" branch to P-V valve
Pipe size, nominal: 6" sch. 40 pipe
Pipe ID (inches): 6.07

Item	Description	Size (in)	Qty	Unit Equivalent Length (ft)	Total Equivalent Length (ft)
1	Straight Pipe	6	1	3.0	3.0
2	Tee, branch	6	1	30.4	30.4
	Sum (pipe run #2)				33.4

Table 3 **Calculation of Maximum Liquid Transfer Rate as Imposed by the Capacity of the Cargo Tank Venting System (Continued)**

A. Calculate pressure drop using Darcy's equation:

	Pipe run #1	Pipe run #2	Pipe run #3
Description:	8" Branch (Exp trunk to vapor header)	8" Vapor header to PV Valve Branch	6" branch to P-V valve
Pipe ID:	7.98 (in)	7.98 (in)	6.07 (in)
Equiv. Pipe Length (table 2a):	65.0 (feet)		
Equiv. Pipe Length (table 2b):		82.1 (feet)	33.4 (feet)
Darcy friction factor:	0.014	0.014	0.015

	CHRIS Code	Name	Vapor-air Mixture Weight Density (from Table 1) (lb/ft^3)	Liquid Transfer Rate (filling) (bbl/hr)	Vapor Growth Rate	Vapor Volumetric Flow Rate (bbl/hr)	Mean Velocity (ft/s)	Pressure Drop (pipe run #1) (psig)	Vapor Volumetric Flow Rate (bbl/hr)	Mean Velocity (ft/s)	Pressure Drop (pipe run #2) (psig)	Vapor Volumetric Flow Rate (bbl/hr)	Mean Velocity (ft/s)	Pressure Drop (pipe run #2) (psig)	Pressure Drop (Total) (psig)	Air Equivalent Volumetric Flow Rate (bbl/hr)
1	AAC	Acetic Acid	0.083	4,800	1.018	4888	21.95	0.006	4888	21.95	0.007	4888	37.94	0.013	0.026	5030
2	DFF	Distillates: Flashed Feed Stocks	0.105	4,800	1.047	5027	22.57	0.008	5027	22.57	0.010	5027	39.01	0.017	0.035	5814
3	DSR	Distillates: Straight Run	0.105	4,800	1.047	5027	22.57	0.008	5027	22.57	0.010	5027	39.01	0.017	0.035	5817
4	GAK	Gasoline blending stocks: Alkylates	0.219	4,800	1.250	6000	26.94	0.024	6000	26.94	0.030	6000	46.56	0.051	0.104	10033
5	GAT	Gasoline: Automotive	0.219	4,800	1.250	6000	26.94	0.024	6000	26.94	0.030	6000	46.56	0.051	0.104	10033
6	GAV	Gasoline: Aviation	0.219	4,800	1.250	6000	26.94	0.024	6000	26.94	0.030	6000	46.56	0.051	0.104	10033
7	GRF	Gasoline blending stocks: Reformates	0.219	4,800	1.250	6000	26.94	0.024	6000	26.94	0.030	6000	46.56	0.051	0.104	10033
8	GSR	Gasoline: Straight Run	0.219	4,800	1.250	6000	26.94	0.024	6000	26.94	0.030	6000	46.56	0.051	0.104	10033
9	JPF	Jet Fuels: JP-4	0.136	4,800	1.070	5134	23.05	0.011	5134	23.05	0.013	5134	39.84	0.023	0.047	6749
10	JPO	Jet Fuels: JP-1	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.007	4814	37.36	0.012	0.024	4866
11	JPT	Jet Fuels: JP-3	0.174	4,800	1.170	5616	25.22	0.016	5616	25.22	0.021	5616	43.58	0.035	0.072	8371
12	JPV	Jet Fuels: JP-5	0.080	4,800	1.002	4810	21.60	0.006	4810	21.60	0.007	4810	37.33	0.012	0.024	4860
13	KRS	Kerosene	0.081	4,800	1.003	4814	21.62	0.006	4814	21.62	0.007	4814	37.36	0.012	0.025	4889
14	MNS	Mineral Spirits	0.082	4,800	1.004	4818	21.63	0.006	4818	21.63	0.007	4818	37.39	0.012	0.025	4925
15	NCT	Naphtha: Coal Tar	0.081	4,800	1.004	4818	21.63	0.006	4818	21.63	0.007	4818	37.39	0.012	0.025	4882
16	NSS	Naphtha: Stoddard Solvent	0.081	4,800	1.004	4818	21.63	0.006	4818	21.63	0.007	4818	37.39	0.012	0.025	4906
17	NSV	Naphtha: Solvent	0.081	4,800	1.004	4818	21.63	0.006	4818	21.63	0.007	4818	37.39	0.012	0.025	4885
18	NVM	Naphtha: VM & P	0.081	4,800	1.004	4818	21.63	0.006	4818	21.63	0.007	4818	37.39	0.012	0.025	4906
19	ODS	Oils: Diesel	0.081	4,800	1.003	4814	21.62	0.006	4814	21.62	0.007	4814	37.36	0.012	0.025	4889
20	OFR	Oils, Fuel: 4	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.007	4814	37.36	0.012	0.024	4866
21	OFV	Oils, Fuel: 5	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.007	4814	37.36	0.012	0.024	4866
22	OLB	Oils, Misc: Lubricating	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.007	4814	37.36	0.012	0.024	4866
23	OMT	Oils, Misc: Motor	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.007	4814	37.36	0.012	0.024	4866
24	OOD	Oils, Fuel: 1-D	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.007	4814	37.36	0.012	0.024	4866
25	OON	Oils, Fuel: No. 1	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.007	4814	37.36	0.012	0.024	4866
26	ORG	Oils, Misc: Range	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.007	4814	37.36	0.012	0.024	4866
27	OSX	Oils, Fuel: No. 6	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.007	4814	37.36	0.012	0.024	4866
28	OTD	Oils, Fuel: 2-D	0.086	4,800	1.014	4866	21.85	0.006	4866	21.85	0.008	4866	37.76	0.013	0.027	5101
29	OTW	Oils, Fuel: 2	0.097	4,800	1.011	4854	21.79	0.007	4854	21.79	0.009	4854	37.67	0.015	0.030	5391
														max =	0.104	10033

Greatest pressure drop to P-V valve: 0.10 (psig) Gasoline: Automotive

High velocity P-V valve pressure setting: 2.00 (psig)
Back pressure imposed by P-V valve @ highest flow rate (see 2.34 (psig)
Total back pressure imposed on cargo tank by venting system: 2.44 (psig)
Max design working pressure of tanks: 3.00 (psig)

Conclusion: At the maximum cargo loading rate, the total back pressure imposed by the tank venting system does not exceed the maximum design working pressure of the tanks.

B. Check vacuum relieving capacity at maximum discharge rate:
Opening vacuum setting for PV Valve: 0.5 (psig)

Maximum discharge rate (total): 1920 (bbl/hr)
Corresponding vacuum at max discharge rate: (see attached PV 0.50 (psig)

Table 4 **Calculation of the Maximum Liquid Transfer Rate as Imposed by the pressure drop between the most remote tank and the facility vapor connection (Ref: 46 CFR 39.30-1(d)(3):**

Note: Darcy's equation will be used to estimate the pressure drop of the vapor-air mixture through the vent piping from the farthest tank in terms of equivalent pipe length (#2S and #2P) to the facility connection. Equivalent length for this path is calculated using Crane's Technical Paper 410 (Ref. 4) and Cameron Hydraulic Data handbook (Ref. 9)

Calculate equivalent lengths of pipe:

a. Pipe run #1

Description: 8" Branch (Tank to vapor header)
Pipe size, nominal: 8" sch. 40 pipe
Pipe ID (inches): 7.98

Item	Description	Size (in)	Qty	Unit Equivalent Length (ft)	Total Equivalent Length (ft)
1	Entrance	8	1	23.3	23.3
2	Straight Pipe	8	1	1.9	1.9
3	Tee, branch	8	1	39.9	39.9
	Sum (pipe run #1)				65.0

b. Pipe run #2

Description: 8" Vapor header to the shore connection branch
Pipe size, nominal: 8" sch. 40 pipe
Pipe ID (inches): 7.98

Item	Description	Size (in)	Qty	Unit Equivalent Length (ft)	Total Equivalent Length (ft)
1	Straight Pipe	8	1	86.0	86.0
2	Tee, run	8	1	13.3	13.3
3	Tee, branch	8	1	39.9	39.9
	Sum (pipe run #2)				139.2

c. Pipe run #3

Description: 8" Branch to the shore connection
Pipe size, nominal: 8" sch. 40 pipe
Pipe ID (inches): 7.98

Item	Description	Size (in)	Qty	Unit Equivalent Length (ft)	Total Equivalent Length (ft)
1	Straight Pipe	8	1	20.0	20.0
2	Tee, branch	8	1	39.9	39.9
3	Valve, Gate	8	1	8.6	8.6
	Sum (pipe run #3)				68.5

Table 5 **Calculation of the Maximum Liquid Transfer Rate as Imposed by the pressure drop between the most remote tank and the facility vapor connection (Ref: 46 CFR 39.: 1(d)(3) (continued):**

1. Calculate pressure drop using Darcy's equation:

Pipe run #1
Description: 8" Branch (Tank to vapor header)
Pipe ID: 7.98 (in)
Equivalent Length of Pipe (from Table 4a): 65.0 (feet)
Darcy friction factor: 0.014

Pipe run #2
Description: 8" Vapor header to the shore connection branch
Pipe ID: 7.98 (in)
Equivalent Length of Pipe (from Table 4b): 139.2 (feet)
Darcy friction factor: 0.014

Pipe run #3
Description: 8" Branch to the shore connection
Pipe ID: 7.98 (in)
Equivalent Length of Pipe (from Table 4c): 68.5 (feet)
Darcy friction factor: 0.014

	CHRIS Code	Name	Vapor-air Mixture Weight Density (from Table 1) (lb/ft^3)	Liquid Transfer Rate (filling) (bbl/hr)	Vapor Growth Rate	Vapor Volumetric Flow Rate (bbl/hr)	Mean Velocity (ft/s)	Pressure Drop (pipe run #1) (psig)	Vapor Volumetric Flow Rate (bbl/hr)	Mean Velocity (ft/s)	Pressure Drop (pipe run #2) (psig)	Vapor Volumetric Flow Rate (bbl/hr)	Mean Velocity (ft/s)	Pressure Drop (pipe run #3) (psig)	Pressure Drop (Total) (psig)	Air Equivalent Volumetric Flow Rate (bbl/hr)
1	AAC	Acetic Acid	0.083	4,800	1.018	4888	21.95	0.006	4888	21.95	0.013	4888	21.95	0.006	0.025	5030
2	DFF	Distillates: Flashed Feed Stocks	0.105	4,800	1.047	5027	22.57	0.008	5027	22.57	0.017	5027	22.57	0.008	0.033	5814
3	DSR	Distillates: Straight Run	0.105	4,800	1.047	5027	22.57	0.008	5027	22.57	0.017	5027	22.57	0.008	0.033	5817
4	GAK	Gasoline blending stocks: Alkylates	0.219	4,800	1.250	6000	26.94	0.024	6000	26.94	0.050	6000	26.94	0.025	0.099	10033
5	GAT	Gasoline: Automotive	0.219	4,800	1.250	6000	26.94	0.024	6000	26.94	0.050	6000	26.94	0.025	0.099	10033
6	GAV	Gasoline: Aviation	0.219	4,800	1.250	6000	26.94	0.024	6000	26.94	0.050	6000	26.94	0.025	0.099	10033
7	GRF	Gasoline blending stocks: Reformates	0.219	4,800	1.250	6000	26.94	0.024	6000	26.94	0.050	6000	26.94	0.025	0.099	10033
8	GSR	Gasoline: Straight Run	0.219	4,800	1.250	6000	26.94	0.024	6000	26.94	0.050	6000	26.94	0.025	0.099	10033
9	JPF	Jet Fuels: JP-4	0.136	4,800	1.070	5134	23.05	0.011	5134	23.05	0.023	5134	23.05	0.011	0.045	6749
10	JPO	Jet Fuels: JP-1	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.012	4814	21.62	0.006	0.023	4866
11	JPT	Jet Fuels: JP-3	0.174	4,800	1.170	5616	25.22	0.016	5616	25.22	0.035	5616	25.22	0.017	0.069	8371
12	JPV	Jet Fuels: JP-5	0.080	4,800	1.002	4810	21.60	0.006	4810	21.60	0.012	4810	21.60	0.006	0.023	4860
13	KRS	Kerosene	0.081	4,800	1.003	4814	21.62	0.006	4814	21.62	0.012	4814	21.62	0.006	0.023	4889
14	MNS	Mineral Spirits	0.082	4,800	1.004	4818	21.63	0.006	4818	21.63	0.012	4818	21.63	0.006	0.024	4925
15	NCT	Naphtha: Coal Tar	0.081	4,800	1.004	4818	21.63	0.006	4818	21.63	0.012	4818	21.63	0.006	0.023	4882
16	NSS	Naphtha: Stoddard Solvent	0.081	4,800	1.004	4818	21.63	0.006	4818	21.63	0.012	4818	21.63	0.006	0.024	4906
17	NSV	Naphtha: Solvent	0.081	4,800	1.004	4818	21.63	0.006	4818	21.63	0.012	4818	21.63	0.006	0.023	4885
18	NVM	Naphtha: VM & P	0.081	4,800	1.004	4818	21.63	0.006	4818	21.63	0.012	4818	21.63	0.006	0.024	4906
19	ODS	Oils: Diesel	0.081	4,800	1.003	4814	21.62	0.006	4814	21.62	0.012	4814	21.62	0.006	0.023	4889
20	OFR	Oils, Fuel: 4	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.012	4814	21.62	0.006	0.023	4866
21	OFV	Oils, Fuel: 5	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.012	4814	21.62	0.006	0.023	4866
22	OLB	Oils, Misc: Lubricating	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.012	4814	21.62	0.006	0.023	4866
23	OMT	Oils, Misc: Motor	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.012	4814	21.62	0.006	0.023	4866
24	OOD	Oils, Fuel: 1-D	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.012	4814	21.62	0.006	0.023	4866
25	OON	Oils, Fuel: No. 1	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.012	4814	21.62	0.006	0.023	4866
26	ORG	Oils, Misc: Range	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.012	4814	21.62	0.006	0.023	4866
27	OSX	Oils, Fuel: No. 6	0.080	4,800	1.003	4814	21.62	0.006	4814	21.62	0.012	4814	21.62	0.006	0.023	4866
28	OTD	Oils, Fuel: 2-D	0.086	4,800	1.014	4866	21.85	0.006	4866	21.85	0.013	4866	21.85	0.006	0.025	5101
29	OTW	Oils, Fuel: 2	0.097	4,800	1.011	4854	21.79	0.007	4854	21.79	0.015	4854	21.79	0.007	0.028	5391
														max =	0.099	10033

2. Compare pressure drop to P-V valve pressure settings:

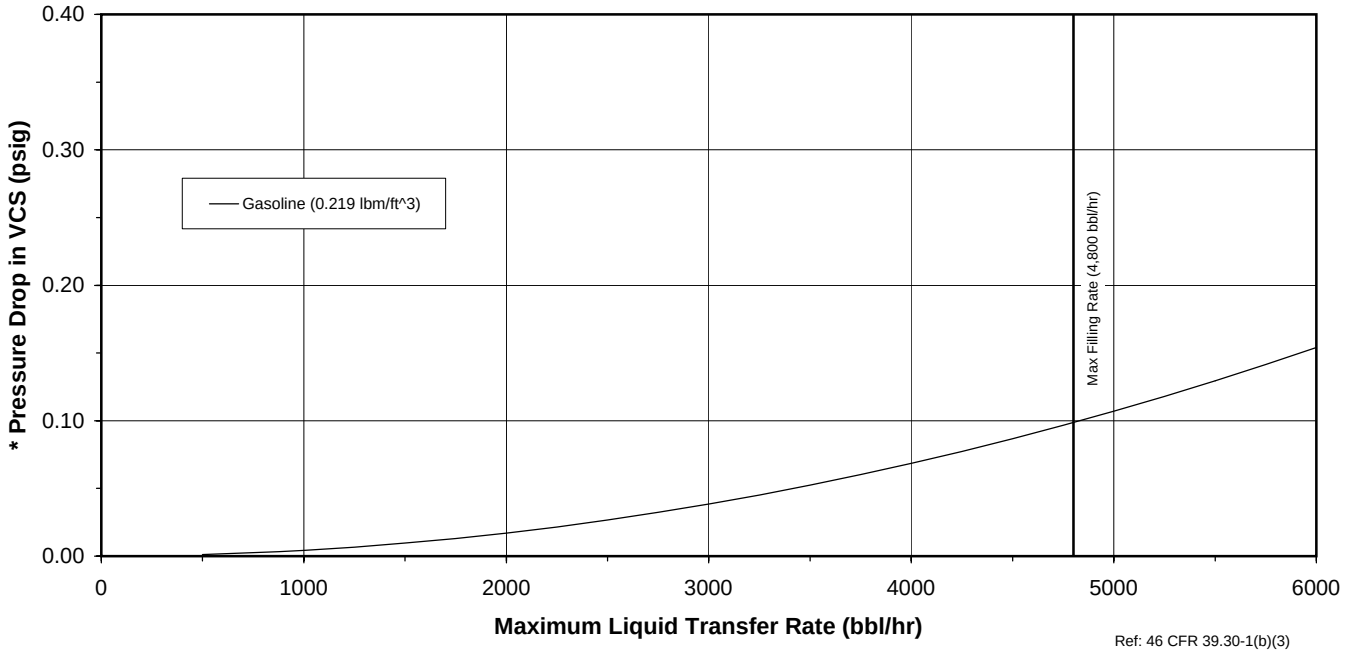
a. High-velocity P-V Valve pressure setting: 2.00 (psig)
b. Cargo tank P-V Valve pressure setting: 2.00 (psig)
c. 80% of lowest P-V Valve Pressure Setting: 1.60 (psig)
d. Highest Pressure Drop from Tank to Facility Connection: 0.10 (psig) for Gasoline: Automotive
e. Max Allowable Back Pressure at Facility Connection: 1.50 (psig)

Conclusion: For the cargo with the highest pressure drop (Gasoline), the pressure drop is 0.10 psig. This, when added to the back pressure at the facility vapor connection must not exceed 80% of the pressure setting of any P-V valve in the cargo tank venting system. Therefore, the maximum allowable back pressure at the shore facility must not exceed 1.50 psig when loading with Gasoline at the maximum liquid transfer rate (4,800 bbl/hr).

Graphs as required by 46 CFR 39.30-1(b)(3)

Curve of Loading Rate vs. Pressure Drop

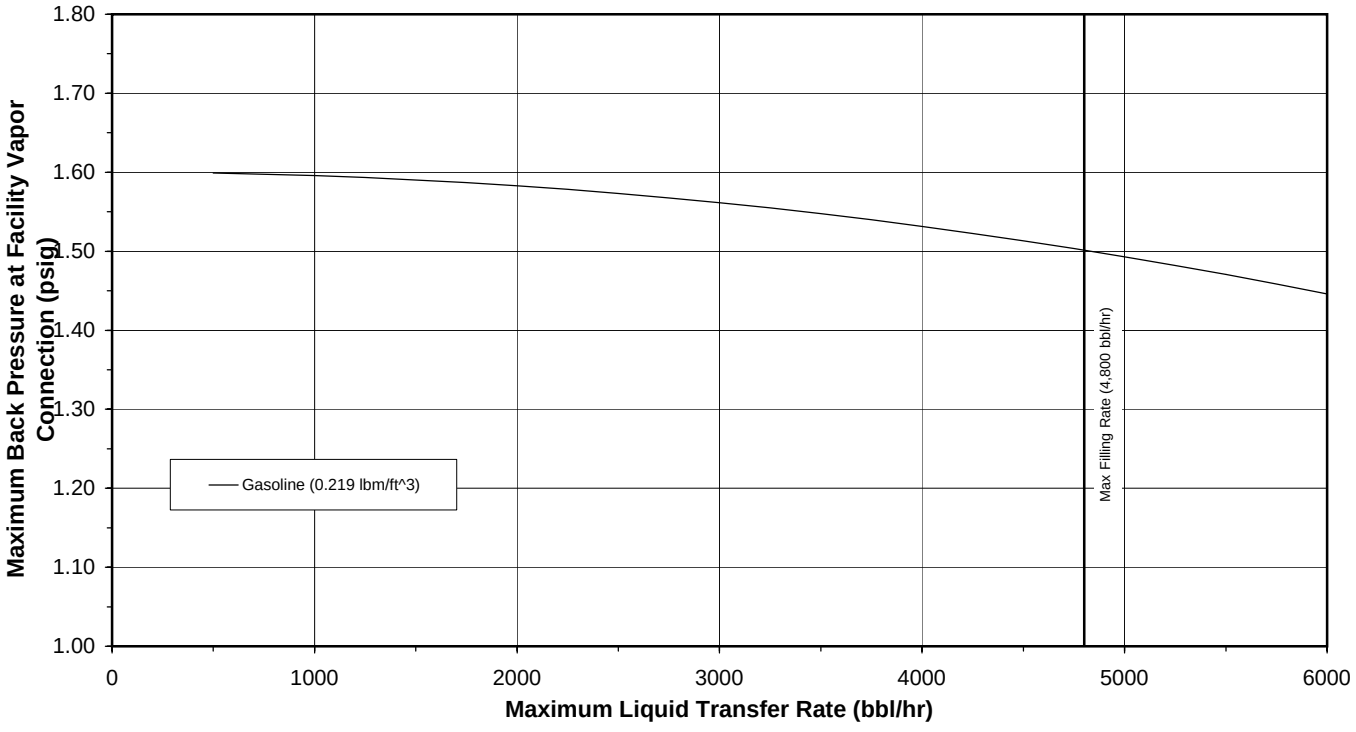
Conrad Hulls 801, 802



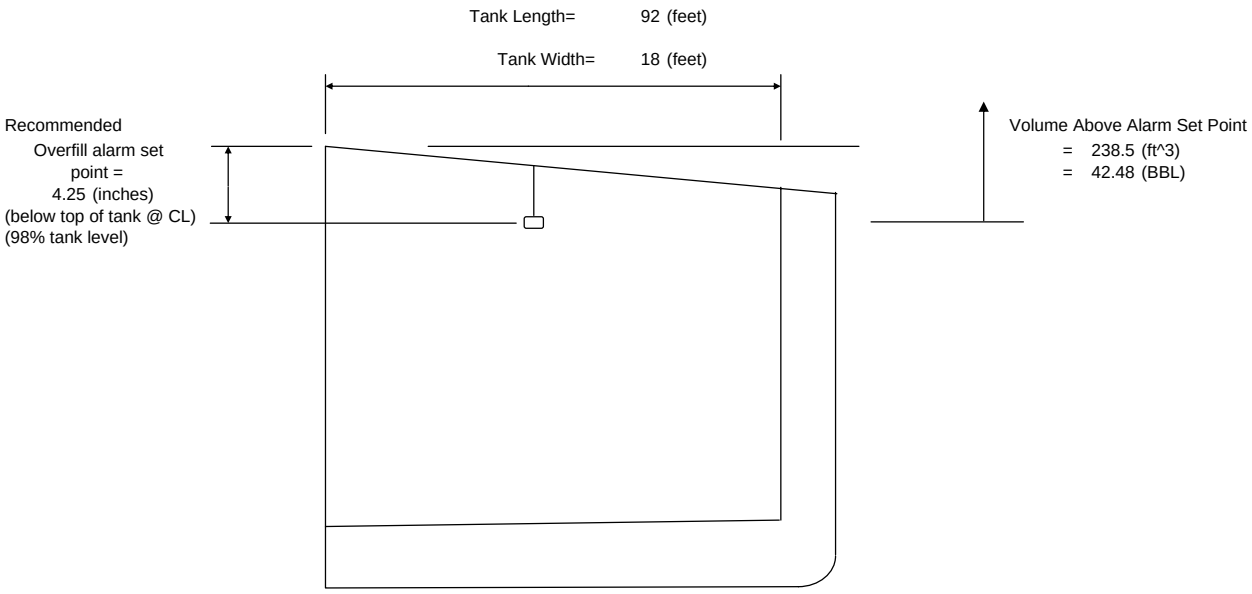
Ref: 46 CFR 39.30-1(b)(3)

Curve of Allowable Back Pressure at Facility Connection

Conrad Hulls 801, 802



Calculation of Overfill Alarm Set Point
(Cargo tanks #1 and #2)



Maximum Cargo Loading Rate (per tank)	=	2,400 (bbl/hr)
	=	40.00 (bbl/min)
Minimum allowable time from alarm to overflow	=	60 (sec)
Actual volume above overfill alarm set point	=	42.48 (bbl)
Actual time from alarm to overflow	=	63.72 (sec)

Therefore, at the maximum loading rate per tank, the person in charge of the transfer operations has more than 60 seconds from the overfill alarm to stop the transfer operations before the tank overflows.

** Recommended set point of overfill alarm = 4.25 (inches)

** Note: Or 98.5%, whichever is lower (to comply with 33CFR155.775)

REFERENCES

1. 46 CFR 32.55-25, Venting of cargo tanks of tank barges constructed on or after July 1, 1951 - B/ALL
2. 46 CFR 39.20-11, Vapor overpressure and vacuum protection - TB/ALL
3. 46 CFR 39.30-1, Operational Requirements - TB/ALL
4. Flow of Fluids Through Valves, Fittings, and Pipe; Crane Technical Paper No. 410
5. USCG Guidelines for Determining the Maximum Liquid Transfer Rate for a Tank Vessel Transferring a Flammable or Combustible Cargo Using a Vapor Control System
6. Dwg. P-05, Vapor Recovery Piping Arrgt.
7. USCG CHRIS (Chemical Hazards Response Information System) Manual.
8. 46 CFR 39.20-9, Tank Barge Liquid Overfill Protection - B/ALL
9. Cameron Hydraulic Data, 15th edition

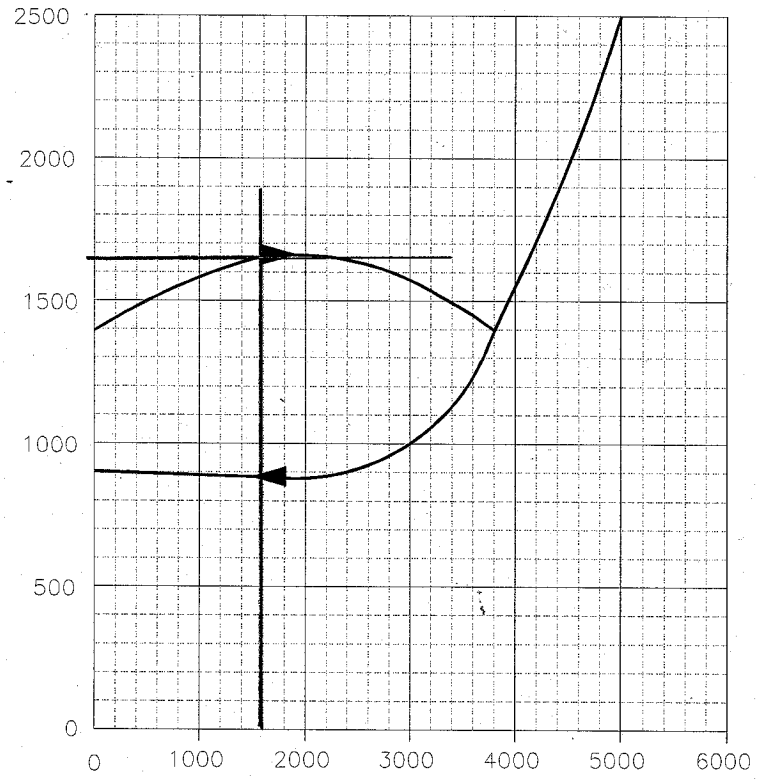
LIST OF ATTACHMENTS

1. Flow Capacity Curves for High-Velocity P-V Valve
2. Vacuum flow diagram for High-Velocity P-V Valve

HIGH VELOCITY VENT VALVE FLOW CAPACITY CURVE

MODEL : U-ISO-H-150
SIZE : 6" (150A)
SETTING PRESSURE : 1400mmAq

VALVE INLET PRESSURE, mmAq
(1mmAq = 0.0014286psi)



FLOW CAPACITY CURVE, SCMH(Standard Cubic Meter per Hour)
(1SCMH = 6.289bbl/hr)

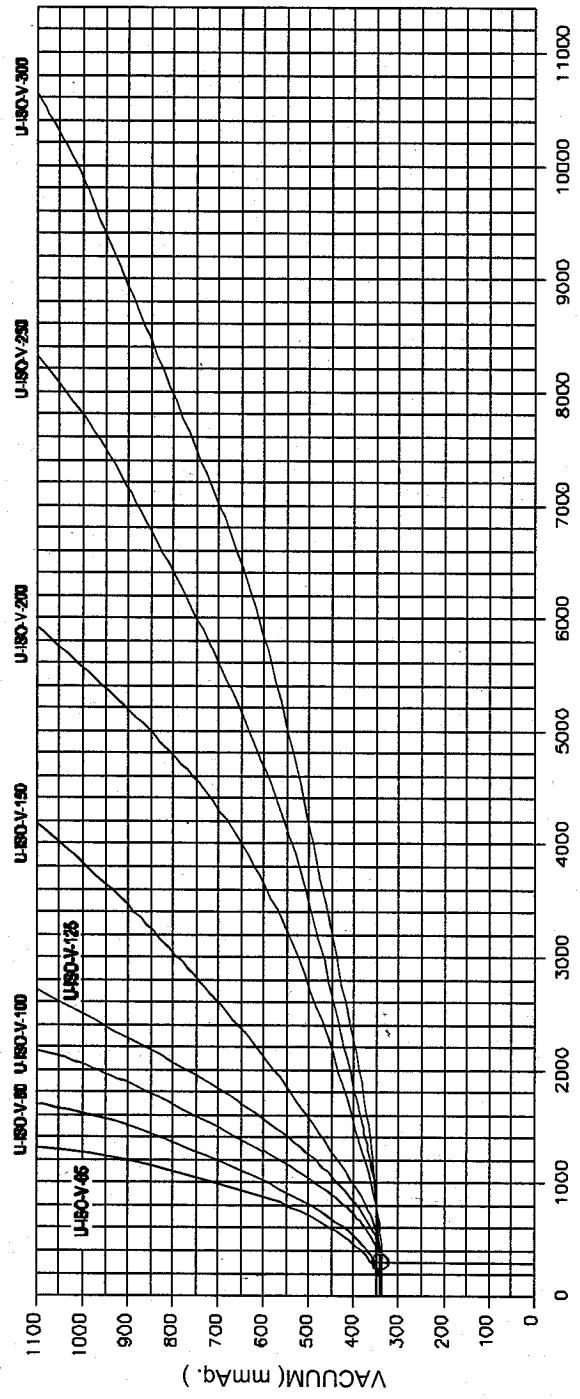
MAX. AIR-EQUIVALENT VOLUMETRIC FLOW RATE = 10,033 bbl/hr
= 1,595 SCMH

BACKPRESSURE @ 1,595 SCMH = 1,640 mmAq = 2.34 psi

APPLICABLE STANDARD	TEST CONDITION	
IMO MSC/Circ.677 & 1009 ISO15364:2000 API Standard 2000	FLOW TEST PERFORMED ON EQUIPMENT USING AIR, AT TEMP.T=15.6℃ AND AMBIENT PRESSURE P=1.0332Kg/cm²	SHEET NO. 1/1

FLOW CAPACITY CURVE GRAPH

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



MAX. DISCHARGE RATE OF 1,920 bbl/hr = 305 SCMH

VACUUM @ 305 SCMH = 350 mm Aq = 0.5 psi

TANKTECH

TITLE HIGH VELOCITY PRESSURE RELIEF VALVE
U-ISO-V-SERIES