

# **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.: 38207**

**TRINITY - MADISONVILLE HULL No.: 2213-1 Thru 4**

**USCG MSC PROJECT No.: Pending**

**October 23, 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: 2213-1 Thru 4/CBC 317 - CBC 320

CONTRACT: 38207  
BY: MEC  
DATE: 23-Oct-13

## VCS SYSTEM INFORMATION

### 1. GENERAL DESCRIPTION OF VESSEL:

A. TMP HULL NUMBERS 2213-1 Thru 4  
B. NAME (S): CBC 317 - CBC 320  
C. OFFICIAL NUMBER: Pending  
D. USCG MSC FILE NUMBER: Pending  
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 38207P-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/ft<sup>3</sup>  
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<br>(in) | UNIT EQ.<br>LENGTH<br>(FT) | TOTAL EQ.<br>LENGTH<br>(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        | 105.33   |       | 7.981     | 1.00                       | 105.33                      |           |
| 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                |          |       |           |                            | 408.03                      |           |

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 | $\rho$ @ 115°F<br>(LBS/CUFT) | f     | PIPE DIA<br>(FT) | TOTAL EQ.<br>LENGTH<br>(FT) | FLOW<br>RATE<br>(CUFT/SEC) | V<br>(FT/SEC) | PRESSURE<br>DROP<br>(PSI) |
|------|------------------------------|-------|------------------|-----------------------------|----------------------------|---------------|---------------------------|
| Air  | 0.069                        | 0.014 | 0.665            | 408.03                      | 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<br>(in) | UNIT EQ.<br>LENGTH<br>(FT) | TOTAL EQ.<br>LENGTH<br>(FT) |              |
|--------------------|---------------|----------|-------|-----------|----------------------------|-----------------------------|--------------|
| Tank Drop          |               | 177.75   |       | 7.891     | 1.00                       | 177.75                      | (From Above) |
| Straight Pipe      |               | 232.736  |       | 7.981     | 1.00                       | 232.74                      |              |
| 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<br>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              |               |          |       |           |                            | 693.300                     |              |

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: | 10.20* 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 0.85ft 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 (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) |
|----|------------|--------------------------------------------------------------------------------|------------|----------|-------|-----------|---------|---------------------------------|--------|-------------|----------|--------------------------|-------------------|--------------------------|------------------------------|----------------------------------------------------|------------------------------------------------------|
|    |            |                                                                                |            |          |       |           |         |                                 |        |             |          |                          |                   |                          |                              |                                                    |                                                      |
| 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    | 0.082                    | 1.007             | 5033                     | 5212                         | 0.039                                              | 0.066                                                |
| 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                         | 0.054                                              | 0.091                                                |
| 3  | ADN        | Adiponitrile                                                                   | 37         | O        | E     | II        | 1       | No                              | 0.950  | 0.010       | 3.730    | 0.076                    | 1.000             | 5001                     | 5009                         | 0.036                                              | 0.060                                                |
| 4  | AEE        | Aminoethylethanolamine                                                         | 8          | O        | E     | III       | 1       | .55-1(b)                        | 1.030  | 0.010       | 3.590    | 0.076                    | 1.000             | 5001                     | 5009                         | 0.036                                              | 0.060                                                |
| 5  | AHO        | Anthracene oil (Coal tar fraction)                                             | 33         | O        | NA    | II        | N/A     | No                              | 1.030  | 0.010       | 3.590    | 0.076                    | 1.000             | 5001                     | 5009                         | 0.036                                              | 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                         | 0.036                                              | 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    | 0.087                    | 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                         | 0.101                                              | 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                                              | 0.366                                                |
| 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(c)                        | 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(c)                        | 0.720  | 3.700       | 3.500    | 0.120                    | 1.074             | 5370                     | 6736                         | 0.064                                              | 0.109                                                |
| 23 | DIP        | Diisopropanolamine                                                             | 8          | O        | E     | III       | 1       | .55-1(c)                        | 0.980  | 0.010       | 4.590    | 0.076                    | 1.000             | 5001                     | 5010                         | 0.036                                              | 0.061                                                |
| 24 | DMB        | Dimethylethanolamine                                                           | 8          | O        | D     | III       | 1       | .56-1(b), (c)                   | 0.890  | 0.516       | 3.030    | 0.081                    | 1.010             | 5052                     | 5216                         | 0.039                                              | 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(c)                        | 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                         | 0.047                                              | 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                         | 0.047                                              | 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                         | 0.057                                              | 0.096                                                |
| 32 | DPU        | 1,3-Dichloropropene                                                            | 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                                              | 0.061                                                |
| 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-Ethylcyclohexylamine                                                         | 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        | Ethylenediamine                                                                | 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                         | 0.037                                              | 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                     | 5078                         | 0.037                                              | 0.062                                                |
| 45 | ETC        | Ethylene cyanohydrin                                                           | 20         | O        | E     | III       | 1       | No                              | 1.040  | 0.010       | 2.450    | 0.076                    | 1.000             | 5001                     | 5007                         | 0.036                                              | 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                         | 0.036                                              | 0.060                                                |

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) |
|----|------------|---------------------------------------------------------------------------------------------------|------------|----------|-------|-----------|---------|--------------------------------------------|--------|-------------|----------|--------------------------|-------------------|--------------------------|------------------------------|---------------------------------------------------|------------------------------------------------------|
| 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       | 1.104    | 0.053                    | 1.112             | 5560                     | 4623                         | 0.030                                             | 0.052                                                |
| 50 | IAI        | iso-Decyl acrylate                                                                                | 14         | O        | E     | III       | 2       | .50-70(a), .50-81(a), (b), .55-1(c)        | 0.890  | 0.010       | 7.300    | 0.076                    | 1.001             | 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                                             | 0.301                                                |
| 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                                             | 0.140                                                |
| 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                         | 0.114                                             | 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                         | 0.063                                             | 0.106                                                |
| 55 | MCK        | Methylcyclopentadiene dimer                                                                       | 30         | O        | C     | III       | 1       | No                                         | 0.941  | 0.040       | 0.930    | 0.076                    | 1.001             | 5004                     | 5008                         | 0.036                                             | 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                                             | 0.061                                                |
| 57 | MEP        | 2-Methyl-5-ethylpyridine                                                                          | 9          | O        | E     | III       | 1       | .55-1(e)                                   | 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        | Mesityl 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                         | 0.050                                             | 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(e)                                   | 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                                             | 0.087                                                |
| 70 | PRD        | Pyridine                                                                                          | 9          | O        | C     | III       | 1       | .55-1(e)                                   | 0.980  | 1.300       | 2.720    | 0.087                    | 1.026             | 5130                     | 5477                         | 0.043                                             | 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                         | 0.036                                             | 0.060                                                |
| 72 | SDD        | Sodium chloride solution (50% or less)                                                            | 0          | O        | NA    | III       | N/A     | .50-73                                     | 0.850  | 0.010       | 0.010    | 0.076                    | 1.000             | 5001                     | 5003                         | 0.036                                             | 0.060                                                |
| 73 | SSH        | Sodium sulfide, hydrosulfide solution (H2S 15 ppm or less)                                        | 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 15 ppm but less 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                                             | 0.061                                                |
| 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                                             | 0.061                                                |
| 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 | TEIN       | Triethylamine                                                                                     | 7          | O        | C     | II        | 3       | .55-1(e)                                   | 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                                             | 0.061                                                |
| 85 | THF        | Tetrahydrofuran                                                                                   | 41         | O        | C     | III       | 1       | .50-70(b)                                  | 0.890  | 8.500       | 1.350    | 0.090                    | 1.170             | 5850                     | 6370                         | 0.058                                             | 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                         | 0.037                                             | 0.062                                                |
| 90 | ACP        | Acetophenone                                                                                      | 18         | D        | E     | NA        | 1       | NA                                         | 1.030  | 0.600       | 4.140    | 0.085                    | 1.012             | 5060                     | 5350                         | 0.041                                             | 0.069                                                |
| 91 | ACT        | Acetone                                                                                           | 18         | D        | C     | NA        | 1       | NA                                         | 0.790  | 10.000      | 2.000    | 0.123                    | 1.200             | 6000                     | 7636                         | 0.083                                             | 0.141                                                |
| 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        | Buyl 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: 2213-1 Thru 4/CBC 317 - CBC 320

CONTRACT: 38207

BY: MEC

DATE: 23-Oct-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                         | 0.051                                              | 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                         | 0.037                                              | 0.062                                                |
| 99  | CHN        | Cyclohexanol                                                           | 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                                              | 0.110                                                |
| 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 | DA A       | 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                         | 0.134                                              | 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                                              | 0.061                                                |
| 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                         | 0.036                                              | 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        | Diocetyl 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 | EGY        | Ethylene glycol                                                        | 20         | D        | E     | NA        | 1       | NA    | 1.130  | 0.010       | 2.210    | 0.076                    | 1.000             | 5001                     | 5007                         | 0.036                                              | 0.060                                                |
| 117 | EG L       | Ethylene glycol diacetate                                              | 34         | D        | E     | NA        | 1       | NA    | 1.130  | 0.010       | 1.000    | 0.076                    | 1.000             | 5001                     | 5005                         | 0.036                                              | 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                                              | 0.061                                                |
| 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                         | 0.036                                              | 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                                              | 0.061                                                |
| 127 | HXN        | Hexanol                                                                | 20         | D        | D     | NA        | 1       | NA    | 0.820  | 1.000       | 3.520    | 0.088                    | 1.020             | 5100                     | 5487                         | 0.043                                              | 0.073                                                |
| 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                                              | 0.061                                                |
| 133 | KRS        | Kerosene                                                               | 33         | D        | D     | NA        | 1       | NA    | 0.810  | 0.150       | 4.500    | 0.079                    | 1.003             | 5015                     | 5100                         | 0.063                                              | 0.061                                                |
| 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                                              | 0.102                                                |
| 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                         | 0.072                                              | 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        | D/E   | 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: 2213-1 Thru 4/CBC 317 - CBC 320

CONTRACT: 38207

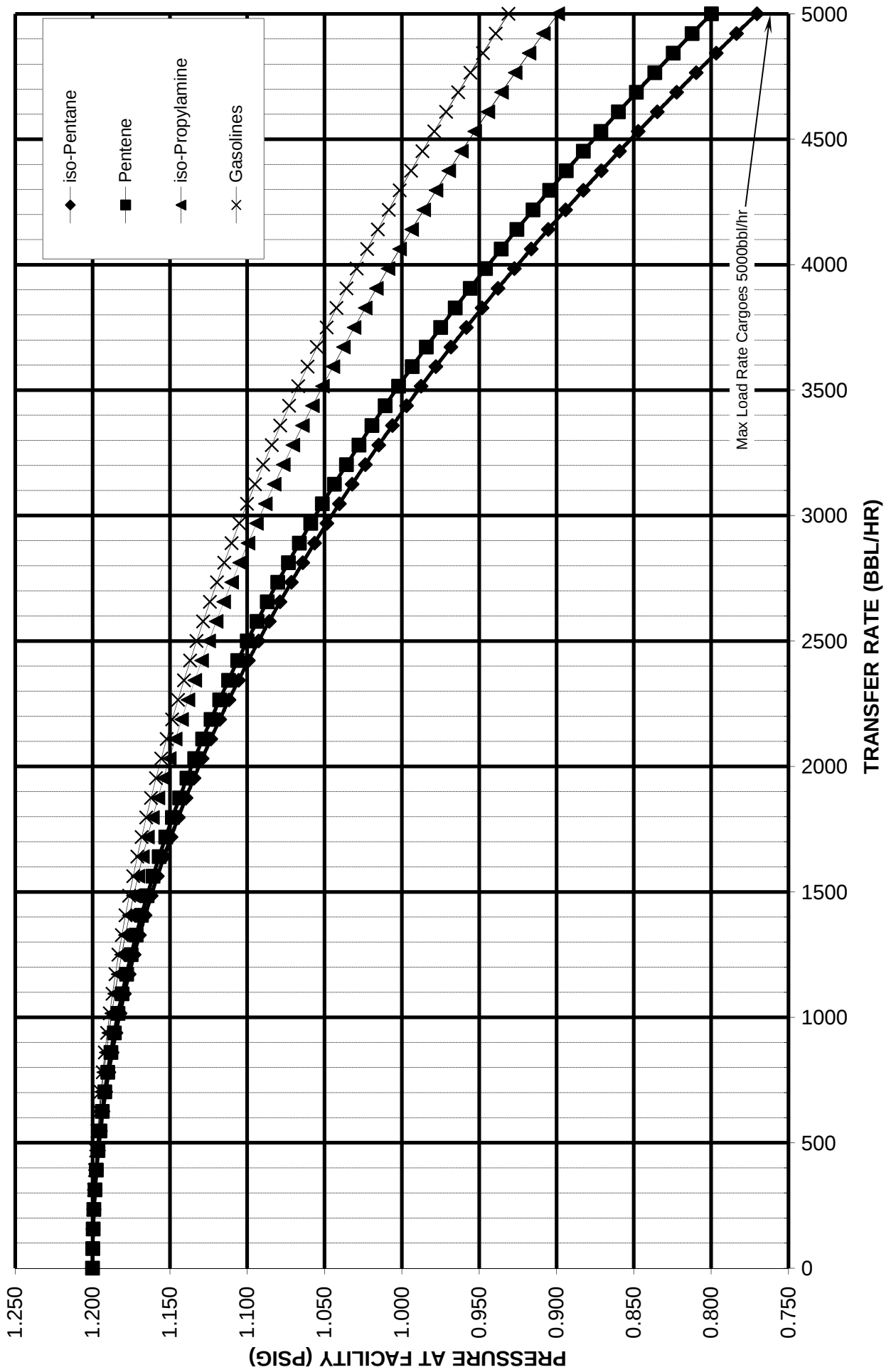
BY: MEC

DATE: 23-Oct-2013

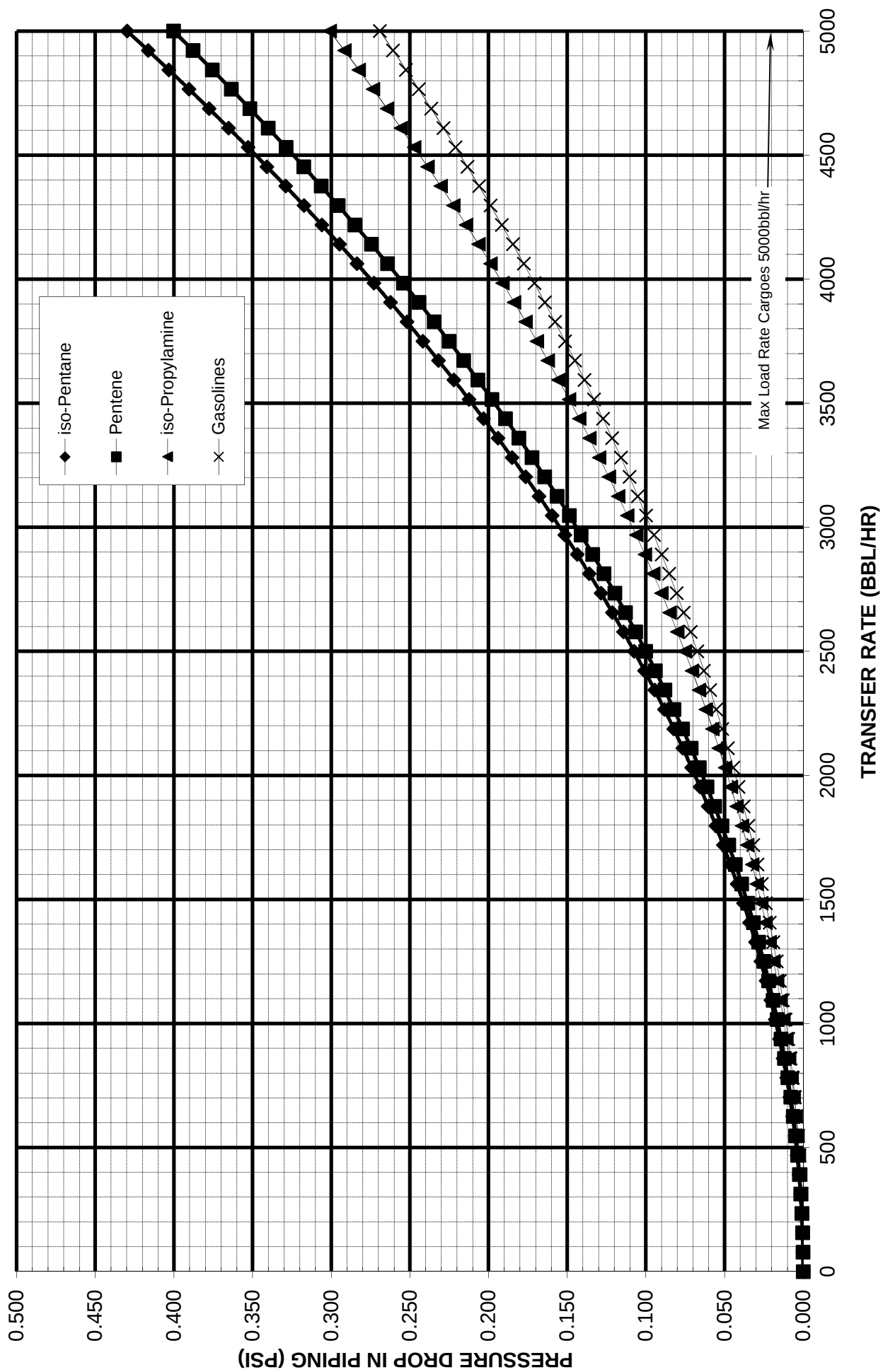
TABLE 1 - VAPOR CONTROL SYSTEM CALCULATIONS

|                         | 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                        | 0.050                                              | 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                        | 0.036                                              | 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                       | 0.236                                              | 0.400                                                |
| 154                     | PTY        | iso-Pentane                                            | 30         | D        | A     | III       | 5       | NA    | 0.620  | 27.000      | 2.480    | 0.347                    | 1.250             | 6250                   | 13350                       | 0.253                                              | 0.430                                                |
| 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                                              | 0.061                                                |
| 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                       | 0.253                                              | 0.430                                                |
| 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                       | 0.253                                              | 0.430                                                |

# 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/ft<sup>3</sup>  
b. Cargo Name \_\_\_\_\_ lbm/ft<sup>3</sup>

6. **VCS Categories Requested (list):** \_\_\_\_\_

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

|                                                         | Cargo A<br>psi | Cargo B<br>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 | <input type="checkbox"/> | Setting in psig _____ |
| b. Overfill Control Shutdown      | <input type="checkbox"/> |                       |
| c. Spill Valve                    | <input type="checkbox"/> |                       |
| d. Rupture Disk                   | <input type="checkbox"/> |                       |

Meets ASTM F1271 ☐

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](http://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 | 73.83a          | 11.04p    | 17.08 |
| CT2.P                   | INTACT TANK | 160.63a         | 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                   | 5325.1     | 1.050     | 979.90          | 74.08a   | 11.86p   | 9.37     |       |
| CT2.P                   | 5195.8     | 1.050     | 956.10          | 161.15a  | 11.86p   | 9.37     |       |
| CT3.P                   | 4917.3     | 1.050     | 904.86          | 245.33a  | 11.85p   | 9.00     |       |
| Total Tanks----->       |            |           | 2,840.86        | 157.93a  | 11.86p   | 9.25     |       |
| 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                   | 5058.8     | 1.050     | 930.90          | 74.06a   | 11.93p   | 9.01     | 1.28  |
| CT2.P                   | 4936.0     | 1.050     | 908.30          | 161.13a  | 11.93p   | 9.01     | 1.28  |
| CT3.P                   | 4671.3     | 1.050     | 859.60          | 245.75a  | 11.91p   | 8.62     | 1.43  |
| Total Tanks----->       |            |           | 2,698.80        | 158.05a  | 11.92p   | 8.89     |       |
| 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                   | 5245.1     | 1.050     | 965.18          | 74.06a   | 11.93p   | 9.26     | 0.77  |
| CT2.P                   | 5117.7     | 1.050     | 941.75          | 161.13a  | 11.93p   | 9.26     | 0.77  |
| CT3.P                   | 4842.8     | 1.050     | 891.16          | 245.46a  | 11.91p   | 8.88     | 0.82  |
| Total Tanks----->       |            |           | 2,798.09        | 157.95a  | 11.92p   | 9.14     |       |
| Distances in FEET.----- |            |           |                 |          |          |          |       |

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

TANK STATUS

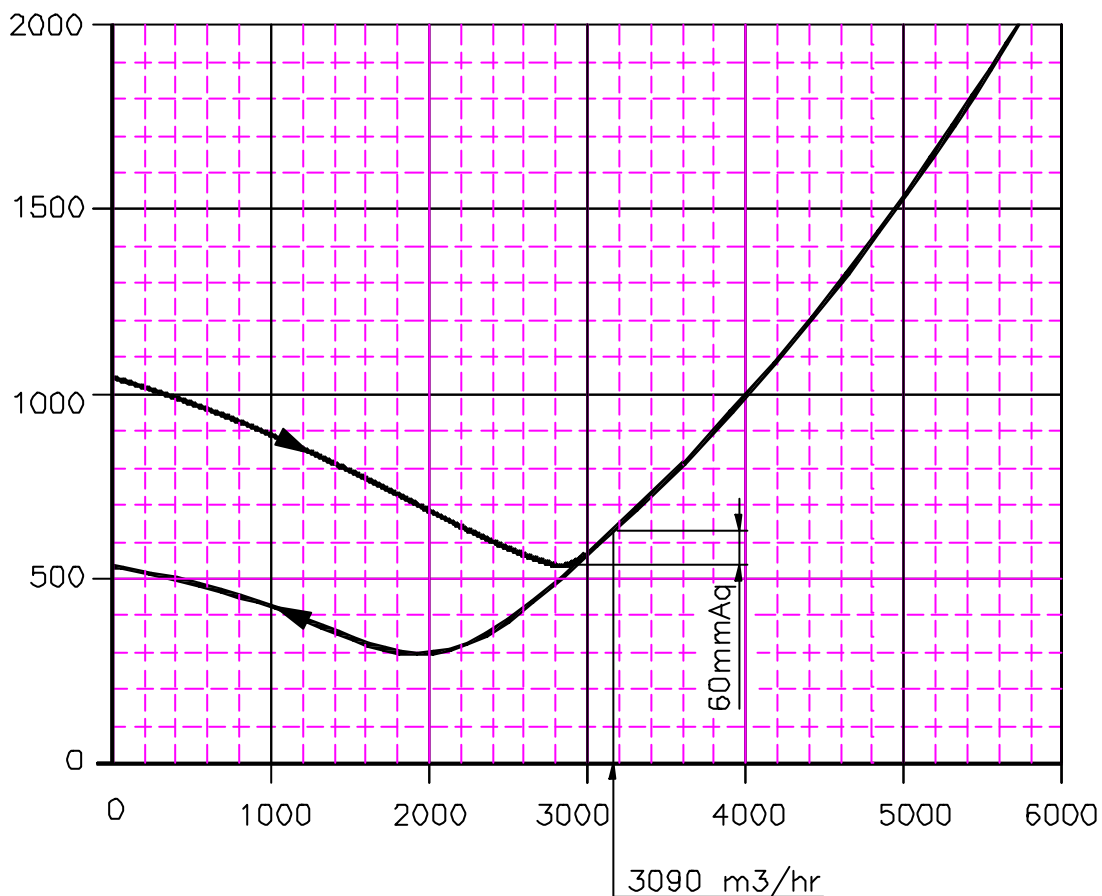
Trim: zero, Heel: zero

| Part-----               | BBLs.----- | SpGr----- | Weight(ST)----- | LCG----- | TCG----- | VCG----- | RefHt |
|-------------------------|------------|-----------|-----------------|----------|----------|----------|-------|
| CT1.P                   | 5241.7     | 1.050     | 964.55          | 74.06a   | 11.93p   | 9.25     | 0.78  |
| CT2.P                   | 5112.4     | 1.050     | 940.76          | 161.13a  | 11.93p   | 9.25     | 0.79  |
| CT3.P                   | 4833.4     | 1.050     | 889.43          | 245.48a  | 11.91p   | 8.87     | 0.85  |
| Total Tanks----->       |            |           | 2,794.74        | 157.92a  | 11.92p   | 9.13     |       |
| 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)

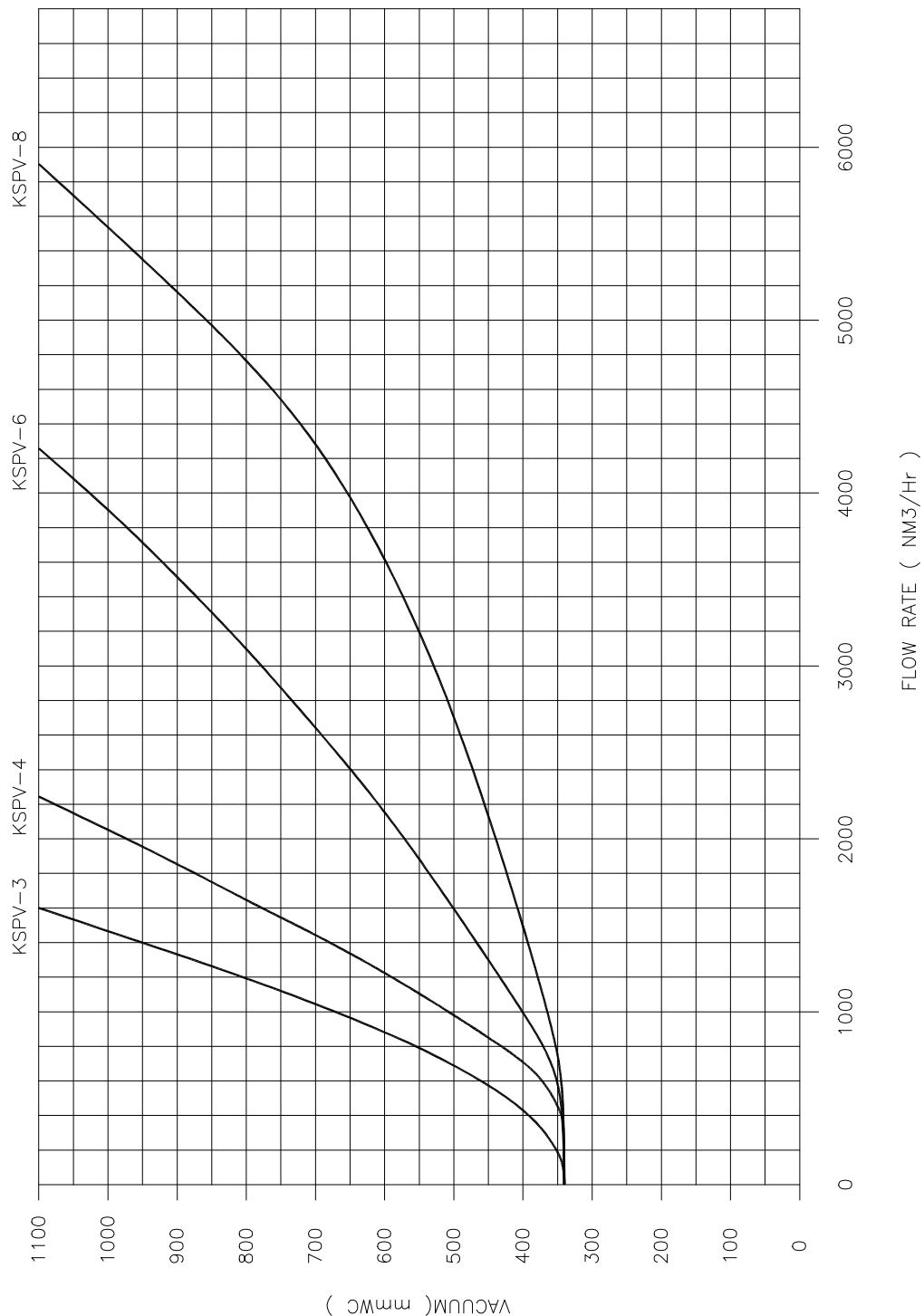


FLOW CAPACITY CURVE, SCMH(Standard cubic meter per hour)  
 (1SCMH = 6.289BBL/hr)

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

# 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*