



# MARINE SOLUTIONS, INC.

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E-mail

MSI/161201/S05  
Commanding Officer (MSC)  
Attn: Chief-Tank Vessel & Offshore Branch  
United States Coast Guard, STOP 7430  
2703 Martin Luther King Jr. Ave., SE  
Washington, DC 20593.

April 17, 2017

Sub: 200'-0" x 35' x 12'-0" Double Skin Tank Barges (D/O) (Type I Hull)  
Barge Name(s): "CBC 1390 thru CBC 1399"  
Southwest Shipyard Hulls: 9768 thru 9777  
Plan Submittal

Encl.: 1. Dwg. No. 161201VP-1, SH 1 of 2, Rev 1 "Vapor Piping"  
2. Dwg. No. 161201VP-1, SH 2 of 2, Rev 1 "Vapor Piping"  
3. Revised Vapor Recovery Calculations  
4. VCS Form

Ref: 1. USCG Project P020756  
2. MSC letter # C1-1700672 dated February 28, 2017

Dear Commanding Officer:

Your office with reference 2 approved the previous version of subject enclosures.

We have relocated the PV valve close to vent stack and revised the drawings and calculations.

With this letter, we request you to kindly review the enclosures and advise us of your approval with or without comments.

Please do not hesitate to call at 615-364-9598 if you have question.

Thank you,

Chetan Kumaria, PE, MBA

**VAPOR COLLECTION SYSTEM CALCULATIONS**

**FOR**

**BARGE NAME(s): "CBC 1390" thru "CBC 1399"**

**SOUTHWEST SHIPYARD HULL(s): 9768 thru 9777  
(MSC PROJECT No. P020756)**

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

**CANAL BARGE COMPANY, INC.**

**January 29, 2017  
Rev. April 17, 2017**

**Prepared by:**

A handwritten signature in black ink, appearing to read 'Chetan Kumaria', is written over a horizontal line.

**Chetan Kumaria, PE, MBA  
MARINE SOLUTIONS, INC.  
P.O. Box 218197  
NASHVILLE, TN. 37221-8197.  
615-364-9598**

# MARINE SOLUTIONS, INC.

Rev. 1 dated April 17, 2017

## VCS SYSTEM INFORMATION:

### 1. GENERAL DESCRIPTION OF VESSEL:

A. NAME (S): CBC 1390 THRU CBC 1399  
B. USCG PROJECT NUMBER: P020756  
C. DIMENSIONS: 200'-0" X 35'-0" X 12'-6"  
D. SERVICE: TANK BARGE (O/D)  
E. MAX. DESIGN WORKING PRESSURE: 3.5 PSIG  
F. PV VALVE PRESSURE SETTING: 1.5 PSIG  
G. PV VALVE VACUUM SETTING: 0.5 PSIG  
H. MAX. DISCHARGE RATE: 800 BBL/HR

### 2. VAPOR CONTROL SYSTEM

A. PIPE DIAMETER: 7.981 INCHES IPS  
B. PIPE LENGTHS: A- 1'-11 15/16" B-1'-5 7/8" C-44'-11 11/32" D-8'-3 61/64", E-42'-3 43/64"  
F- 4'-10 19/32" G-2'-7 3/16" H-43'-11 11/32" I-2'-4 9/16"  
J-4'-1 1/4" K-8'-3 7/8"

#### C. P/V VALVE VENTING CAPACITY:

(1) 6" BERGAN KLPH, SET @ 1.5 PSI  
(2) MAX. CAPACITY: 19433 BBL/HR OF AIR  
(3) 0.5 PSIG VAC.

#### D. SPILL VALVE RELIEVING CAPACITY:

NON INSTALLED

#### E. MAX. VAPOR-AIR MIXTURE DENSITY:

0.346 LBM/FT<sup>3</sup> FOR SUB D  
0.213 LBM/FT<sup>3</sup> FOR SUB O

#### F. MAX. LIQUID LOADING RATE:

3500 BBL/HR

#### G. DARCY FRICTION FACTOR:

0.014

#### H. VCS CARGOES:

SEE TABLE 1 & TABLE 4

#### I. ADDITIONAL MIS. INFORMATION:

SYSTEM IS DESIGNED TO ACCOMMODATE INTERNAL VISUAL INSPECTION.

## VCS CALCULATIONS

### 1. CARGO AUTHORITY::

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

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

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

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

Tank 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 | UNIT EQ.<br>LENGTH (FT) | TOTAL EQ.<br>LENGTH (FT) |
|---------------|----------|-------------------------|--------------------------|
| Straight Pipe | 1        | 106.55                  | 106.55                   |
| Entrance      | 1        | 37.05                   | 37.05                    |
| T Branch      | 4        | 39.91                   | 159.64                   |
| 8"X6"RED      | 1        | 39.88                   | 39.88                    |
| T Run Thru    | 6        | 13.3                    | 79.8                     |
| Total         |          |                         | 422.92                   |

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 & Table 4.

Using a 3500 bbl/h liquid transfer rate, the vapor-air mixture and air-equivalent volumetric flow rate for each cargo are given in Table 1 & Table 4. At a setting of 1.5 psig, the Bergan KLPH-6 PV Valve has an adequate pressure relieving capacity of air for each cargo listed in Table 1 & Table 4. The greatest pressure drop in the venting system (1.695 psig) does not exceed the cargo tank maximum design working pressure of 3.5 psi.

The maximum vacuum that can exist in a tank is 0.511 psig. The barges are constructed as per ABS rules and regulations for a pressure of 3.5 psig and are tested for a pressure of 3.5 psig. Therefore the maximum vacuum of 0.511 psig is within the design capacity of these barges and an unloading rate of 800 bbl/h is acceptable.

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

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

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

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

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

**TABLE 3**

| PIPE/FITTINGS | QUANTITY | UNIT EQ.<br>LENGTH (FT) | TOTAL EQ.<br>LENGTH (FT) |
|---------------|----------|-------------------------|--------------------------|
| Straight Pipe | 1        | 161.185                 | 161.185                  |
| Entrance      | 1        | 37.05                   | 37.05                    |
| T Branch      | 4        | 39.91                   | 159.64                   |
| T Run         | 6        | 13.33                   | 79.98                    |
| 8" Gate Valve | 1        | 5.32                    | 5.32                     |
|               |          | Total                   | 443.175                  |

Pressure drop at the maximum liquid transfer rate of 3500 bbl/h along this path for each cargo is given in Tables 1 & 4. The largest pressure drop does not exceed 80 percent of the P/V valve pressure setting (1.2 psig).

TABLE 1 (SUB CHAPTER "D" CARGOES)

| CHRIS<br>CODE | NAME                                                  | VCS<br>CAT | LIQ<br>SG | VAPOR<br>PRESS | VAPOR<br>SG | VAPOR<br>AIR<br>WEIGHT<br>DENSITY | VAPOR<br>GROWTH<br>RATE | PRESSURE<br>DROP TO PV<br>VALVE IN<br>VCS (psig)<br>(LOADING) | VAPOR<br>VOLUMETRIC<br>FLOW RATE<br>(bbl/h) | AIR<br>EQUIVALENT<br>VOLUMETRIC<br>FLOW RATE | PRESSURE<br>DROP TO<br>SHORE<br>CONNECTION<br>IN VCS (psig)<br>(LOADING)* | PRESSURE<br>DROP TO PV<br>VALVE IN<br>VCS (psig)<br>(UNLOADING) | PRESSURE<br>DROP TO<br>SHORE<br>CONNECTION<br>IN VCS (psig)<br>(UNLOADING)* |
|---------------|-------------------------------------------------------|------------|-----------|----------------|-------------|-----------------------------------|-------------------------|---------------------------------------------------------------|---------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------|
| 1 ACT         | Acetone                                               | 1          | 0.79      | 10             | 2           | 0.123                             | 1.2000                  | 0.042                                                         | 4200                                        | 5340                                         | 0.044                                                                     | 0.002                                                           | 0.002                                                                       |
| 2 ACP         | Acetophenone                                          | 1          | 1.03      | 0.6            | 4.14        | 0.085                             | 1.0120                  | 0.021                                                         | 3542                                        | 3741                                         | 0.022                                                                     | 0.001                                                           | 0.001                                                                       |
| 19 AAT        | Amyl Acetate (iso-)                                   | 1          | 0.88      | 0.33           | 4.48        | 0.081                             | 1.0066                  | 0.020                                                         | 3523                                        | 3645                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 20 AAI        | Amyl Alcohol (iso-, n-, sec-, primary) (See also IAA) | 1          | 0.82      | 0.3            | 3.04        | 0.079                             | 1.0060                  | 0.019                                                         | 3521                                        | 3586                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 21 AAN        | Amyl Alcohol (n-)                                     | 1          | 0.82      | 0.3            | 3.04        | 0.079                             | 1.0060                  | 0.019                                                         | 3521                                        | 3586                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 23 APM        | Amyl Alcohol, Primary                                 | 1          | 0.82      | 0.3            | 3.04        | 0.079                             | 1.0060                  | 0.019                                                         | 3521                                        | 3586                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 24 ASE        | Amyl Alcohol, (sec-)                                  | 1          | 0.82      | 0.3            | 3.04        | 0.079                             | 1.0060                  | 0.019                                                         | 3521                                        | 3586                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 26 IAA        | Amyl Alcohol, (iso-)                                  | 1          | 0.82      | 0.3            | 3.04        | 0.079                             | 1.0060                  | 0.019                                                         | 3521                                        | 3586                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 34 BAL        | Benzyl Alcohol                                        | 1          | 1.05      | 0.1            | 3.73        | 0.077                             | 1.0020                  | 0.018                                                         | 3507                                        | 3535                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 40 BAX        | Butyl Acetate (iso-, n-)                              | 1          | 0.87      | 0.6            | 4           | 0.084                             | 1.0120                  | 0.020                                                         | 3542                                        | 3733                                         | 0.021                                                                     | 0.001                                                           | 0.001                                                                       |
| 42 BTA        | Butyl Acetate (sec-)                                  | 1          | 0.89      | 1.5            | 4           | 0.097                             | 1.0300                  | 0.024                                                         | 3605                                        | 4074                                         | 0.026                                                                     | 0.001                                                           | 0.001                                                                       |
| 44 IAL        | Butyl Alcohol (iso-)                                  | 1          | 0.81      | 0.9            | 2.6         | 0.083                             | 1.0180                  | 0.020                                                         | 3563                                        | 3717                                         | 0.021                                                                     | 0.001                                                           | 0.001                                                                       |
| 46 BAS        | Butyl Alcohol (sec-)                                  | 1          | 0.81      | 1.3            | 2.6         | 0.086                             | 1.0260                  | 0.021                                                         | 3591                                        | 3814                                         | 0.022                                                                     | 0.001                                                           | 0.001                                                                       |
| 47 BAT        | Butyl Alcohol (tert-)                                 | 1          | 0.78      | 2.8            | 2.6         | 0.097                             | 1.0560                  | 0.026                                                         | 3696                                        | 4175                                         | 0.027                                                                     | 0.001                                                           | 0.001                                                                       |
| 48 BPH        | Butyl Benzyl Phthalate                                | 1          | 1.12      | 0.01           | 10.8        | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3510                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 64 CLS        | Caprolactam Solutions                                 | 1          | 1.02      | 0.05           | 3.9         | 0.077                             | 1.0010                  | 0.018                                                         | 3504                                        | 3518                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 70 CUM        | Cumene                                                | 1          | 0.86      | 0.60           | 4.20        | 0.085                             | 1.0120                  | 0.021                                                         | 3542                                        | 3745                                         | 0.022                                                                     | 0.001                                                           | 0.001                                                                       |
| 72 CHX        | Cyclohexane                                           | 1          | 0.78      | 4.5            | 2.9         | 0.116                             | 1.0900                  | 0.033                                                         | 3815                                        | 4714                                         | 0.034                                                                     | 0.002                                                           | 0.002                                                                       |
| 73 CHN        | Cyclohexanol                                          | 1          | 0.95      | 0.15           | 3.45        | 0.078                             | 1.0030                  | 0.019                                                         | 3511                                        | 3549                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 74 CPD        | 1,3-Cyclopentadiene dimer (molten)                    | 1          | 0.69      | 0.25           | 4.55        | 0.080                             | 1.0050                  | 0.019                                                         | 3518                                        | 3612                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 76 CMP        | Cymene (para-)                                        | 1          | 0.86      | 0.11           | 4.62        | 0.078                             | 1.0022                  | 0.019                                                         | 3508                                        | 3550                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 77 DHN        | Decahydronaphthalene                                  | 1          | 0.89      | 0.1            | 4.76        | 0.078                             | 1.0020                  | 0.018                                                         | 3507                                        | 3546                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 78 IDA        | Decaldehyde (iso-)                                    | 1          | 0.83      | 0.01           | 5           | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3504                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 79 DAL        | Decaldehyde (n-)                                      | 1          | 0.83      | 0              | 5.01        | 0.076                             | 1.0000                  | 0.018                                                         | 3500                                        | 3499                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 81 DCE        | Decane                                                | 1          | 0.74      | 0.12           | 4.8         | 0.078                             | 1.0024                  | 0.019                                                         | 3508                                        | 3556                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 82 DAX        | Decyl Alcohol (all isomers) (Decanol)                 | 1          | 0.83      | 0.01           | 5.3         | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3504                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 83 ISA        | Decyl Alcohol (iso-)                                  | 1          | 0.83      | 0.01           | 5.3         | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3504                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 84 DAN        | Decyl Alcohol (n-)                                    | 1          | 0.83      | 0.01           | 5.3         | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3504                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 85 DBZ        | Decylbenzene (n-)                                     | 1          | 0.86      | 0.01           | 7.52        | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3507                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 87 DAA        | Diacetone Alcohol                                     | 1          | 0.97      | 0.1            | 4           | 0.077                             | 1.0020                  | 0.018                                                         | 3507                                        | 3538                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 91 DPA        | Dibutyl Phthalate (ortho-)                            | 1          | 1.05      | 0              | 9.59        | 0.076                             | 1.0000                  | 0.018                                                         | 3500                                        | 3499                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 92 DPT        | Dicyclopentadiene, See 1,3-Cyclopentadiene Dimer 2    | 1          | 0.98      | 0.25           | 4.55        | 0.080                             | 1.0050                  | 0.019                                                         | 3518                                        | 3612                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 93 DEB        | Diethylbenzene                                        | 1          | 0.87      | 0.08           | 4.62        | 0.077                             | 1.0016                  | 0.018                                                         | 3506                                        | 3536                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 94 DEG        | Diethylene Glycol                                     | 1          | 1.12      | 0.01           | 3.66        | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3503                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 95 DME        | Diethylene Glycol Butyl Ether                         | 1          | 0.95      | 0.01           | 5.5         | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3505                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 100 DGA       | Diethylene Glycol Ethyl Ether Acetate                 | 1          | 0.99      | 0.02           | 4.62        | 0.076                             | 1.0004                  | 0.018                                                         | 3501                                        | 3508                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 101 DGM       | Diethylene Glycol Methyl Ether                        | 1          | 1.03      | 0.03           | 4.14        | 0.076                             | 1.0006                  | 0.018                                                         | 3502                                        | 3511                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 111 DBC       | Diisobutylcarbinol                                    | 1          | 0.81      | 0.09           | 4.97        | 0.078                             | 1.0018                  | 0.018                                                         | 3506                                        | 3544                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 112 DBL       | Diisobutylene                                         | 1          | 0.72      | 2              | 3.86        | 0.103                             | 1.0400                  | 0.026                                                         | 3640                                        | 4233                                         | 0.028                                                                     | 0.001                                                           | 0.001                                                                       |
| 113 DIX       | Diisobutyl Ketone                                     | 1          | 0.81      | 0.16           | 4.9         | 0.079                             | 1.0032                  | 0.019                                                         | 3511                                        | 3577                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 119 DIX       | Diisopropylbenzene (all isomer)                       | 1          | 0.86      | 0.03           | 5.6         | 0.077                             | 1.0006                  | 0.018                                                         | 3502                                        | 3516                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 124 DTL       | Dimethyl Phthalate                                    | 1          | 1.19      | 0              | 6.69        | 0.076                             | 1.0000                  | 0.018                                                         | 3500                                        | 3499                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 130 DOP       | Diethyl Phthalate                                     | 1          | 0.98      | 0              | 13.47       | 0.076                             | 1.0000                  | 0.018                                                         | 3500                                        | 3499                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 131 DPN       | Dipentene                                             | 1          | 0.84      | 0.1            | 4.9         | 0.078                             | 1.0020                  | 0.019                                                         | 3507                                        | 3548                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 132 DIL       | Diphenyl                                              | 1          | 0.99      | 0.01           | 5.31        | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3504                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 133 DDO       | Diphenyl, Diphenyl Ether Mixture                      | 1          | 1.07      | 0.01           | 5.86        | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3505                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 134 DPE       | Diphenyl Ether                                        | 1          | 1.07      | 0.01           | 5.87        | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3505                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 136 DPG       | Dipropylene Glycol                                    | 1          | 1.03      | 0.07           | 4.63        | 0.077                             | 1.0014                  | 0.018                                                         | 3505                                        | 3531                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 139 DFF       | Distillates: Flashed Feed Stocks                      | 1          | 0.75      | 2.3            | 3.4         | 0.102                             | 1.0460                  | 0.026                                                         | 3661                                        | 4238                                         | 0.028                                                                     | 0.001                                                           | 0.001                                                                       |
| 140 DSR       | Distillates: Straight Run                             | 1          | 0.73      | 2.3            | 3.4         | 0.102                             | 1.0460                  | 0.026                                                         | 3661                                        | 4238                                         | 0.028                                                                     | 0.001                                                           | 0.001                                                                       |
| 145 DOZ       | Dodecene (all isomers)                                | 1          | 0.76      | 0.02           | 5.81        | 0.076                             | 1.0004                  | 0.018                                                         | 3501                                        | 3511                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 146 DOD       | Dodecene                                              | 1          | 0.76      | 0.02           | 5.81        | 0.076                             | 1.0004                  | 0.018                                                         | 3501                                        | 3511                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 147 DDB       | Dodecylbenzene                                        | 1          | 0.86      | 4.7            | 8.4         | 0.239                             | 1.0940                  | 0.068                                                         | 3829                                        | 6791                                         | 0.071                                                                     | 0.004                                                           | 0.004                                                                       |
| 155 ETG       | Ethoxy Triglycol (crude)                              | 1          | 1.02      | 0              | 6.14        | 0.076                             | 1.0000                  | 0.018                                                         | 3500                                        | 3499                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 156 ETA       | Ethyl Acetate                                         | 1          | 0.9       | 4.5            | 3.04        | 0.119                             | 1.0900                  | 0.034                                                         | 3815                                        | 4774                                         | 0.035                                                                     | 0.002                                                           | 0.002                                                                       |
| 157 EAA       | Ethyl Acetoacetate                                    | 1          | 1.03      | 0.2            | 4.48        | 0.079                             | 1.0040                  | 0.019                                                         | 3514                                        | 3588                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 158 EAL       | Ethyl Alcohol (Ethanol)                               | 1          | 0.79      | 3.5            | 1.6         | 0.086                             | 1.0700                  | 0.023                                                         | 3745                                        | 3979                                         | 0.024                                                                     | 0.001                                                           | 0.001                                                                       |
| 160 ETB       | Ethyl Benzene                                         | 1          | 0.87      | 0.6            | 3.56        | 0.083                             | 1.0120                  | 0.020                                                         | 3542                                        | 3705                                         | 0.021                                                                     | 0.001                                                           | 0.001                                                                       |
| 161 EBT       | Ethyl Butanol                                         | 1          | 0.83      | 0.12           | 3.52        | 0.077                             | 1.0024                  | 0.018                                                         | 3508                                        | 3540                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 162 EBR       | Ethyl Butyrate                                        | 1          | 0.88      | 1              | 4           | 0.090                             | 1.0200                  | 0.022                                                         | 3570                                        | 3885                                         | 0.023                                                                     | 0.001                                                           | 0.001                                                                       |
| 163 EGY       | Ethyl Cyclohexane                                     | 1          | 0.79      | 0.5            | 3.87        | 0.083                             | 1.0100                  | 0.020                                                         | 3535                                        | 3687                                         | 0.021                                                                     | 0.001                                                           | 0.001                                                                       |
| 166 EGL       | Ethylene Glycol                                       | 1          | 1.19      | 0.01           | 2.21        | 0.076                             | 1.0002                  | 0.018                                                         | 3501                                        | 3501                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |

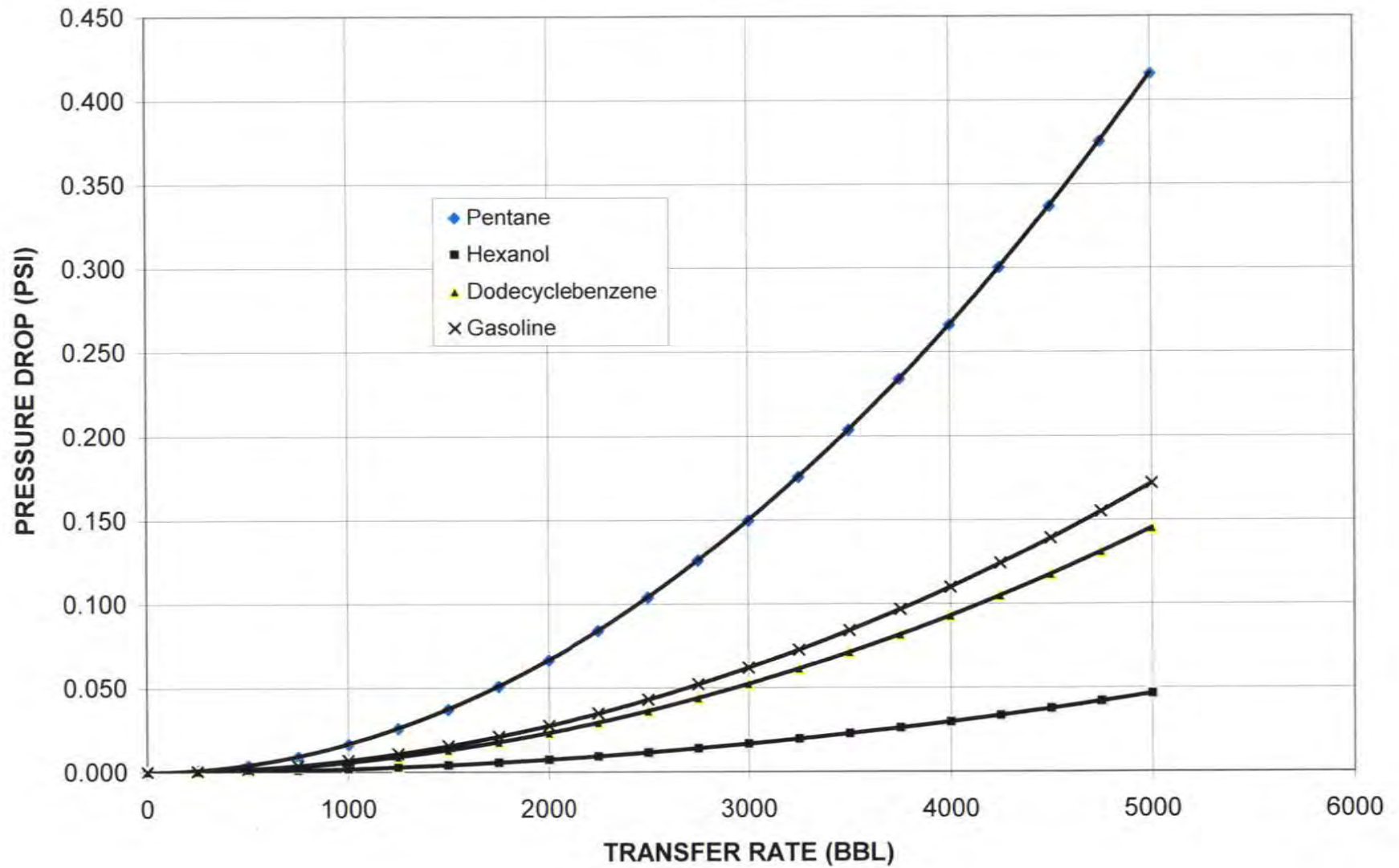


|     |     |                                                       |   |      |       |      |       |        |       |      |      |       |       |       |
|-----|-----|-------------------------------------------------------|---|------|-------|------|-------|--------|-------|------|------|-------|-------|-------|
| 169 | EMA | Ethylene Glycol Butyl Ether Acetate                   | 1 | 0.94 | 0.05  | 5.52 | 0.077 | 1.0010 | 0.018 | 3504 | 3527 | 0.019 | 0.001 | 0.001 |
| 172 | EGY | Ethylene Glycol Diacetate                             | 1 | 1.1  | 0.01  | 5.03 | 0.076 | 1.0002 | 0.018 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 178 | EME | Ethylene Glycol Methyl Ether                          | 1 | 1.1  | 0.01  | 4.8  | 0.076 | 1.0002 | 0.018 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 180 | EPE | Ethylene Glycol Phenyl Ether                          | 1 | 1.1  | 0.01  | 4.8  | 0.076 | 1.0002 | 0.018 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 184 | EHA | 2-Ethylhexaldehyde, See Octyl Aldehydes               | 1 | 0.82 | 0.17  | 4.41 | 0.079 | 1.0034 | 0.019 | 3512 | 3573 | 0.020 | 0.001 | 0.001 |
| 186 | EHX | 2-Ethylhexanol, see Octanol (all isomers)             | 1 | 0.84 | 0.02  | 4.5  | 0.076 | 1.0004 | 0.018 | 3501 | 3508 | 0.019 | 0.001 | 0.001 |
| 190 | EPR | Ethyl Propionate                                      | 1 | 0.89 | 3.5   | 1.6  | 0.086 | 1.0700 | 0.023 | 3745 | 3979 | 0.024 | 0.001 | 0.001 |
| 191 | ETE | Ethyl Toulene                                         | 1 | 0.88 | 0.28  | 4.15 | 0.080 | 1.0056 | 0.019 | 3520 | 3613 | 0.020 | 0.001 | 0.001 |
| 194 | FAM | Formamide                                             | 1 | 1.13 | 0.1   | 1.55 | 0.076 | 1.0020 | 0.018 | 3507 | 3512 | 0.019 | 0.001 | 0.001 |
| 195 | FAL | Furfuryl Alcohol                                      | 1 | 1.13 | 0.05  | 3.4  | 0.077 | 1.0010 | 0.018 | 3504 | 3515 | 0.019 | 0.001 | 0.001 |
| 197 | GAK | Gasoline Blended Stocks: Alkylates                    | 1 | 0.75 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.084 | 0.004 | 0.004 |
| 198 | GRF | Gasoline Blended Stocks: Reformate                    | 1 | 0.8  | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.084 | 0.004 | 0.004 |
| 199 | GAT | Gasolines: Automotive (containing not over 4.23 gr: 1 | 1 | 0.74 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.084 | 0.004 | 0.004 |
| 200 | GAV | Gasolines: Aviation (containing not over 4.86 gram: 1 | 1 | 0.71 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.084 | 0.004 | 0.004 |
| 201 | GCS | Gasolines: Casinghead                                 | 1 | 0.67 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.084 | 0.004 | 0.004 |
| 202 | GPL | Gasolines: Polymer                                    | 1 | 0.75 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.084 | 0.004 | 0.004 |
| 203 | GSR | Gasolines: Straight Run                               | 1 | 0.75 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.084 | 0.004 | 0.004 |
| 204 | GCR | Glycerine                                             | 1 | 1.26 | 0     | 3.17 | 0.076 | 1.0000 | 0.018 | 3500 | 3499 | 0.019 | 0.001 | 0.001 |
| 217 | HMX | Heptane (all isomers) (Methylhexane)                  | 1 | 0.68 | 2.5   | 3.45 | 0.105 | 1.0500 | 0.027 | 3675 | 4313 | 0.029 | 0.001 | 0.001 |
| 218 | HPT | Heptane (n-)                                          | 1 | 0.68 | 2.5   | 3.45 | 0.105 | 1.0500 | 0.027 | 3675 | 4313 | 0.029 | 0.001 | 0.001 |
| 220 | HTX | Heptanol (all isomers)                                | 1 | 0.82 | 0.04  | 4    | 0.077 | 1.0008 | 0.018 | 3503 | 3515 | 0.019 | 0.001 | 0.001 |
| 221 | HTN | Heptanol (all isomers)                                | 1 | 0.82 | 0.04  | 4    | 0.077 | 1.0008 | 0.018 | 3503 | 3515 | 0.019 | 0.001 | 0.001 |
| 222 | HPX | Heptene (all isomers)                                 | 2 | 0.7  | 2.9   | 3.4  | 0.109 | 1.0580 | 0.029 | 3703 | 4426 | 0.030 | 0.002 | 0.002 |
| 223 | THE | Heptene (1-)                                          | 1 | 0.7  | 2.8   | 3.4  | 0.107 | 1.0560 | 0.028 | 3696 | 4395 | 0.030 | 0.001 | 0.002 |
| 229 | HXS | Hexane (all isomers)                                  | 1 | 0.66 | 7     | 3    | 0.142 | 1.1400 | 0.044 | 3990 | 5446 | 0.046 | 0.002 | 0.002 |
| 230 | HXA | Hexane                                                | 1 | 0.66 | 7     | 3    | 0.142 | 1.1400 | 0.044 | 3990 | 5446 | 0.046 | 0.002 | 0.002 |
| 231 | HXO | Hexanoic Acid                                         | 1 | 0.93 | 0.01  | 4    | 0.076 | 1.0002 | 0.018 | 3501 | 3503 | 0.019 | 0.001 | 0.001 |
| 232 | HXN | Hexanol                                               | 1 | 0.82 | 1     | 3.52 | 0.088 | 1.0200 | 0.022 | 3570 | 3837 | 0.023 | 0.001 | 0.001 |
| 234 | HEX | Hexene (all isomers)                                  | 2 | 0.67 | 8     | 2.9  | 0.147 | 1.1600 | 0.047 | 4060 | 5651 | 0.049 | 0.002 | 0.003 |
| 235 | HXE | Hexene (1-)                                           | 1 | 0.67 | 8.2   | 2.9  | 0.149 | 1.1640 | 0.048 | 4074 | 5705 | 0.050 | 0.003 | 0.003 |
| 236 | HXT | Hexene (2-)                                           | 1 | 0.67 | 8.2   | 2.9  | 0.149 | 1.1640 | 0.048 | 4074 | 5705 | 0.050 | 0.003 | 0.003 |
| 238 | HXG | Hexylene Glycol                                       | 4 | 0.92 | 0.01  | 1.1  | 0.076 | 1.0002 | 0.018 | 3501 | 3500 | 0.019 | 0.001 | 0.001 |
| 243 | IPH | Isophorone                                            | 1 | 0.93 | 0.01  | 4.75 | 0.076 | 1.0002 | 0.018 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 244 | JPO | Jet Fuels: JP-1 (Kerosene)                            | 1 | 0.8  | 0.14  | 4.5  | 0.078 | 1.0028 | 0.019 | 3510 | 3561 | 0.020 | 0.001 | 0.001 |
| 245 | JPT | Jet Fuels: JP-3                                       | 1 | 0.8  | 8.51  | 4.5  | 0.216 | 1.1702 | 0.070 | 4096 | 6899 | 0.073 | 0.004 | 0.004 |
| 246 | JPF | Jet Fuels: JP-4                                       | 1 | 0.81 | 3.4   | 4    | 0.124 | 1.0680 | 0.033 | 3738 | 4770 | 0.035 | 0.002 | 0.002 |
| 247 | JPV | Jet Fuels: JP-5 (Kerosene, heavy)                     | 1 | 0.82 | 0.1   | 4    | 0.077 | 1.0020 | 0.018 | 3507 | 3538 | 0.019 | 0.001 | 0.001 |
| 249 | KRS | Kerosene                                              | 1 | 0.81 | 0.15  | 4.5  | 0.078 | 1.0030 | 0.019 | 3511 | 3566 | 0.020 | 0.001 | 0.001 |
| 263 | MTT | Methyl Acetate                                        | 1 | 0.92 | 6.1   | 2.6  | 0.122 | 1.1220 | 0.036 | 3927 | 4970 | 0.038 | 0.002 | 0.002 |
| 265 | MAL | Methyl Alcohol (See Methanol)                         | 1 | 0.79 | 6.63  | 1.1  | 0.079 | 1.1326 | 0.024 | 3964 | 4043 | 0.025 | 0.001 | 0.001 |
| 266 | MAC | Methyl Amyl Acetate                                   | 1 | 0.86 | 0.33  | 4.97 | 0.082 | 1.0066 | 0.020 | 3523 | 3662 | 0.021 | 0.001 | 0.001 |
| 267 | MAA | Methyl Amyl Alcohol                                   | 1 | 0.81 | 0.43  | 3.52 | 0.081 | 1.0086 | 0.020 | 3530 | 3645 | 0.020 | 0.001 | 0.001 |
| 271 | MBK | Methyl n-Butyl Ketone                                 | 1 | 0.81 | 0.97  | 3.5  | 0.087 | 1.0194 | 0.022 | 3568 | 3825 | 0.023 | 0.001 | 0.001 |
| 273 | MBU | Methyl Butyrate                                       | 1 | 0.9  | 1.26  | 3.53 | 0.091 | 1.0252 | 0.023 | 3588 | 3924 | 0.024 | 0.001 | 0.001 |
| 274 | MEK | Methyl Ethyl Ketone                                   | 1 | 0.8  | 4.5   | 2.5  | 0.108 | 1.0900 | 0.030 | 3815 | 4539 | 0.032 | 0.002 | 0.002 |
| 275 | MTF | Methyl Formal (Dimethyl Formal)                       | 1 | 0.86 | 15.42 | 2.6  | 0.192 | 1.3084 | 0.078 | 4579 | 7272 | 0.081 | 0.004 | 0.004 |
| 276 | MHK | Methyl Heptyl Ketone                                  | 1 | 0.83 | 0.06  | 4.9  | 0.077 | 1.0012 | 0.018 | 3504 | 3528 | 0.019 | 0.001 | 0.001 |
| 278 | MIK | Methyl Isobutyl Ketone                                | 1 | 0.8  | 1.15  | 3.45 | 0.089 | 1.0230 | 0.022 | 3581 | 3878 | 0.023 | 0.001 | 0.001 |
| 281 | MNA | 1-Methyl Napthalene                                   | 1 | 1.02 | 0.01  | 4.91 | 0.076 | 1.0002 | 0.018 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 283 | MPN | 2-Methyl-1-Pentene                                    | 1 | 0.69 | 6.3   | 2.9  | 0.132 | 1.1260 | 0.040 | 3941 | 5195 | 0.042 | 0.002 | 0.002 |
| 284 | MTN | 5-Methyl-1-Pentene                                    | 1 | 0.67 | 8.49  | 2.9  | 0.152 | 1.1698 | 0.049 | 4094 | 5782 | 0.052 | 0.003 | 0.003 |
| 286 | MBE | Methyl Tert-Butyl Ether (MTBE)                        | 1 | 0.74 | 0.04  | 3.1  | 0.076 | 1.0008 | 0.018 | 3503 | 3511 | 0.019 | 0.001 | 0.001 |
| 288 | MNS | Mineral Spirits                                       | 1 | 0.75 | 0.2   | 4.3  | 0.079 | 1.0040 | 0.019 | 3514 | 3584 | 0.020 | 0.001 | 0.001 |
| 289 | MRE | Myrcene                                               | 1 | 0.8  | 0.17  | 4.7  | 0.079 | 1.0034 | 0.019 | 3512 | 3578 | 0.020 | 0.001 | 0.001 |
| 295 | NSV | Naphtha: Solvent                                      | 1 | 0.87 | 0.2   | 3.5  | 0.078 | 1.0040 | 0.019 | 3514 | 3567 | 0.020 | 0.001 | 0.001 |
| 296 | NSS | Naphtha: Stoddard Solvant                             | 1 | 0.78 | 0.2   | 4.3  | 0.079 | 1.0040 | 0.019 | 3514 | 3584 | 0.020 | 0.001 | 0.001 |
| 297 | NVM | Naphtha: Varnish Maker's and Painters (75%)           | 1 | 0.77 | 0.19  | 4.3  | 0.079 | 1.0038 | 0.019 | 3513 | 3580 | 0.020 | 0.001 | 0.001 |
| 300 | NAX | Nonane (all isomers)                                  | 1 | 0.72 | 0.27  | 4.4  | 0.080 | 1.0054 | 0.019 | 3519 | 3616 | 0.020 | 0.001 | 0.001 |
| 301 | NAN | Nonane                                                | 1 | 0.72 | 0.27  | 4.4  | 0.080 | 1.0054 | 0.019 | 3519 | 3616 | 0.020 | 0.001 | 0.001 |
| 304 | NON | Nonene                                                | 1 | 0.73 | 0.35  | 4.3  | 0.081 | 1.0070 | 0.020 | 3525 | 3647 | 0.020 | 0.001 | 0.001 |
| 305 | NNS | Nonyl Alcohol (all isomers)                           | 1 | 0.94 | 0.1   | 5    | 0.078 | 1.0020 | 0.019 | 3507 | 3549 | 0.019 | 0.001 | 0.001 |
| 306 | NNN | Nonyl Alcohol                                         | 1 | 0.94 | 0.1   | 5    | 0.078 | 1.0020 | 0.019 | 3507 | 3549 | 0.019 | 0.001 | 0.001 |
| 307 | NNI | Nonyl Alcohol (iso-)                                  | 1 | 0.94 | 0.1   | 5    | 0.078 | 1.0020 | 0.019 | 3507 | 3549 | 0.019 | 0.001 | 0.001 |
| 309 | NNP | Nonyl Phenol                                          | 1 | 0.95 | 0.01  | 7.6  | 0.076 | 1.0002 | 0.018 | 3501 | 3507 | 0.019 | 0.001 | 0.001 |
| 316 | OAX | Octane (all isomers)                                  | 1 | 0.7  | 0.79  | 3.9  | 0.087 | 1.0158 | 0.021 | 3555 | 3797 | 0.022 | 0.001 | 0.001 |
| 317 | OAN | Octane                                                | 1 | 0.7  | 0.79  | 3.9  | 0.087 | 1.0158 | 0.021 | 3555 | 3797 | 0.022 | 0.001 | 0.001 |
| 320 | OTA | Octanol                                               | 1 | 0.83 | 0.01  | 4.48 | 0.076 | 1.0002 | 0.018 | 3501 | 3503 | 0.019 | 0.001 | 0.001 |
| 322 | OTE | Octene (1-)                                           | 1 | 0.72 | 1     | 3.86 | 0.089 | 1.0200 | 0.022 | 3570 | 3871 | 0.023 | 0.001 | 0.001 |
| 324 | OCX | Octyl Alcohol (iso-, n-) (all isomers), See Octanol ( | 1 | 0.83 | 0.01  | 4.48 | 0.076 | 1.0002 | 0.018 | 3501 | 3503 | 0.019 | 0.001 | 0.001 |

|         |                                                        |   |       |        |        |       |        |       |      |       |       |       |       |
|---------|--------------------------------------------------------|---|-------|--------|--------|-------|--------|-------|------|-------|-------|-------|-------|
| 325 IOA | Octyl Alcohol                                          | 1 | 0.83  | 0.01   | 4.48   | 0.076 | 1.0002 | 0.018 | 3501 | 3503  | 0.019 | 0.001 | 0.001 |
| 364 OTW | Fuel No. 2                                             | 1 | 0.88  | 0.56   | 8      | 0.094 | 1.0112 | 0.023 | 3539 | 3943  | 0.024 | 0.001 | 0.001 |
| 366 OFR | Fuel No. 4                                             | 1 | 0.9   | 0.15   | 3.4    | 0.078 | 1.0030 | 0.019 | 3511 | 3548  | 0.019 | 0.001 | 0.001 |
| 367 OFV | Fuel No. 5                                             | 1 | 0.94  | 0.15   | 3.4    | 0.078 | 1.0030 | 0.019 | 3511 | 3548  | 0.019 | 0.001 | 0.001 |
| 368 OSX | Fuel No. 6                                             | 1 | 0.95  | 0.15   | 3.4    | 0.078 | 1.0030 | 0.019 | 3511 | 3548  | 0.019 | 0.001 | 0.001 |
| 382 OIL | OIL, Misc: Crude                                       | 1 | 0.95  | 0.15   | 3.4    | 0.078 | 1.0030 | 0.019 | 3511 | 3548  | 0.019 | 0.001 | 0.001 |
| 383 ODS | OIL, Misc: Diesel                                      | 1 | 0.9   | 0.69   | 3.4    | 0.084 | 1.0138 | 0.020 | 3548 | 3724  | 0.021 | 0.001 | 0.001 |
| 389 OLB | OIL, Misc: Lubricating                                 | 1 | 0.9   | 0.15   | 1      | 0.076 | 1.0030 | 0.018 | 3511 | 3510  | 0.019 | 0.001 | 0.001 |
| 403 ORS | OIL, Misc: Resin                                       | 1 | 1.02  | 0.15   | 1      | 0.076 | 1.0030 | 0.018 | 3511 | 3510  | 0.019 | 0.001 | 0.001 |
| 418 OTB | OIL, Misc: Turbine                                     | 1 | 0.87  | 0.3    | 5.4    | 0.082 | 1.0060 | 0.020 | 3521 | 3661  | 0.021 | 0.001 | 0.001 |
| 429 PDC | Pentadecanol, See Alcohols (C13 and above)             | 1 | 0.83  | 0.01   | 7.88   | 0.076 | 1.0002 | 0.018 | 3501 | 3507  | 0.019 | 0.001 | 0.001 |
| 433 IPT | Pentane (iso-)                                         | 5 | 0.62  | 27     | 2.48   | 0.346 | 1.5400 | 0.195 | 5390 | 11501 | 0.204 | 0.010 | 0.011 |
| 434 PTA | Pentane (n-)                                           | 5 | 0.63  | 20.44  | 2.5    | 0.264 | 1.4088 | 0.124 | 4931 | 9191  | 0.130 | 0.006 | 0.007 |
| 437 PTE | Pentene (1-)                                           | 5 | 0.64  | 24.9   | 2.4    | 0.309 | 1.4980 | 0.164 | 5243 | 10568 | 0.172 | 0.009 | 0.009 |
| 442 PIN | Pinene                                                 | 1 | 0.86  | 0.35   | 4.7    | 0.082 | 1.0070 | 0.020 | 3525 | 3662  | 0.021 | 0.001 | 0.001 |
| 448 PLB | Polybutene                                             | 1 | 0.91  | 0.01   | 79.3   | 0.080 | 1.0002 | 0.019 | 3501 | 3583  | 0.020 | 0.001 | 0.001 |
| 457 PGC | Polypropylene Glycol                                   | 1 | 1.01  | 0.1    | 1      | 0.076 | 1.0020 | 0.018 | 3507 | 3506  | 0.019 | 0.001 | 0.001 |
| 464 IAC | Propyl Acetate (iso-)                                  | 1 | 0.89  | 1.8    | 3.52   | 0.097 | 1.0360 | 0.025 | 3626 | 4101  | 0.026 | 0.001 | 0.001 |
| 465 PAT | Propyl Acetate (n-)                                    | 1 | 0     | 1.85   | 3.52   | 0.098 | 1.0370 | 0.025 | 3630 | 4118  | 0.026 | 0.001 | 0.001 |
| 466 IPA | Propyl Alcohol (iso-)                                  | 1 | 0.79  | 3      | 2.07   | 0.091 | 1.0600 | 0.024 | 3710 | 4060  | 0.025 | 0.001 | 0.001 |
| 467 PAL | Propyl Alcohol (n-)                                    | 1 | 0.8   | 1.2    | 2.07   | 0.082 | 1.0240 | 0.020 | 3584 | 3722  | 0.021 | 0.001 | 0.001 |
| 468 PBZ | Propylbenzene (n-)                                     | 1 | 0.86  | 0.2    | 4.14   | 0.079 | 1.0040 | 0.019 | 3514 | 3580  | 0.020 | 0.001 | 0.001 |
| 469 IPX | Iso-Propylcyclohexane                                  | 1 | 0.8   | 0.01   | 4.35   | 0.076 | 1.0002 | 0.018 | 3501 | 3503  | 0.019 | 0.001 | 0.001 |
| 473 PPG | Propylene Glycol (1,2-Propanediol)                     | 1 | 1.04  | 0.01   | 2.62   | 0.076 | 1.0002 | 0.018 | 3501 | 3501  | 0.019 | 0.001 | 0.001 |
| 476 PME | Propylene Glycol Methyl Ether                          | 1 | 0.92  | 0.7    | 3.11   | 0.083 | 1.0140 | 0.020 | 3549 | 3706  | 0.021 | 0.001 | 0.001 |
| 488 SFL | Sulfolane                                              | 1 | 1.26  | 0.01   | 4.14   | 0.076 | 1.0002 | 0.018 | 3501 | 3503  | 0.019 | 0.001 | 0.001 |
| 493 TTN | Tetradecanol                                           | 1 | 0.82  | 0      | 7.39   | 0.076 | 1.0000 | 0.018 | 3500 | 3499  | 0.019 | 0.001 | 0.001 |
| 494 TTD | 1-Tetradecene, See the olefin or Alpha-Olefin Entries  | 1 | 0.77  | 0.01   | 6.77   | 0.076 | 1.0002 | 0.018 | 3501 | 3506  | 0.019 | 0.001 | 0.001 |
| 496 TTG | Tetraethylene Glycol                                   | 1 | 1.12  | 0.01   | 6.7    | 0.076 | 1.0002 | 0.018 | 3501 | 3506  | 0.019 | 0.001 | 0.001 |
| 497 THN | Tetrahydronaphthalene                                  | 1 | 0.97  | 0.04   | 4.56   | 0.077 | 1.0008 | 0.018 | 3503 | 3517  | 0.019 | 0.001 | 0.001 |
| 499 TOL | Toluene                                                | 1 | 0.87  | 1.5    | 3.14   | 0.091 | 1.0300 | 0.023 | 3605 | 3945  | 0.024 | 0.001 | 0.001 |
| 502 TCP | Tricresyl Phosphate (less than 1% of the ortho isomer) | 1 | 1.16  | 0.01   | 12.69  | 0.077 | 1.0002 | 0.018 | 3501 | 3512  | 0.019 | 0.001 | 0.001 |
| 503 TRD | Tridecane                                              | 1 | 0.76  | 0.02   | 6.4    | 0.076 | 1.0004 | 0.018 | 3501 | 3512  | 0.019 | 0.001 | 0.001 |
| 505 TDN | Tridecanol, See Alcohols (C13 and above)               | 1 | 0.85  | 0.01   | 6.91   | 0.076 | 1.0002 | 0.018 | 3501 | 3506  | 0.019 | 0.001 | 0.001 |
| 506 TDC | 1-Tridecene                                            | 1 | 0.77  | 0.01   | 6.29   | 0.076 | 1.0002 | 0.018 | 3501 | 3505  | 0.019 | 0.001 | 0.001 |
| 508 TEB | Triethylbenzene                                        | 1 | 0.86  | 0.02   | 5.6    | 0.076 | 1.0004 | 0.018 | 3501 | 3510  | 0.019 | 0.001 | 0.001 |
| 509 TEG | Triethylene Glycol                                     | 1 | 1.12  | 0.01   | 5.17   | 0.076 | 1.0002 | 0.018 | 3501 | 3504  | 0.019 | 0.001 | 0.001 |
| 519 TRE | Trimethylbenzenes (all isomers)                        | 1 | 0.89  | 0.14   | 4.2    | 0.078 | 1.0028 | 0.019 | 3510 | 3557  | 0.019 | 0.001 | 0.001 |
| 520 TMB | Trimethyl Benzene (1,2,5-)                             | 1 | 0.89  | 0.14   | 4.14   | 0.078 | 1.0028 | 0.019 | 3510 | 3556  | 0.019 | 0.001 | 0.001 |
| 521 TMD | Trimethyl Benzene (1,2,3-)                             | 1 | 0.89  | 0.14   | 4.14   | 0.078 | 1.0028 | 0.019 | 3510 | 3556  | 0.019 | 0.001 | 0.001 |
| 522 TME | Trimethyl Benzene (1,2,4-) (Pseudocumene)              | 1 | 0.89  | 0.14   | 4.14   | 0.078 | 1.0028 | 0.019 | 3510 | 3556  | 0.019 | 0.001 | 0.001 |
| 529 TRP | Trixylenyl Phosphate                                   | 1 | 1.16  | 0      | 14.2   | 0.076 | 1.0000 | 0.018 | 3500 | 3499  | 0.019 | 0.001 | 0.001 |
| 546 XLX | Xylenes (Ortho-, meta-, para-)                         | 1 | 0.89  | 0.51   | 3.66   | 0.082 | 1.0102 | 0.020 | 3536 | 3680  | 0.021 | 0.001 | 0.001 |
| 547 XLM | Xylene (M-)                                            | 1 | 0.87  | 0.51   | 3.66   | 0.082 | 1.0102 | 0.020 | 3536 | 3680  | 0.021 | 0.001 | 0.001 |
| 548 XLO | Xylene (O-)                                            | 1 | 0.89  | 0.4    | 3.66   | 0.081 | 1.0080 | 0.019 | 3528 | 3641  | 0.020 | 0.001 | 0.001 |
| 549 XLP | Xylene (P-)                                            | 1 | 0.86  | 0.51   | 3.66   | 0.082 | 1.0102 | 0.020 | 3536 | 3680  | 0.021 | 0.001 | 0.001 |
| 550 XYL | Xylenol                                                | 1 | 1.01  | 0.1    | 3.66   | 0.077 | 1.0020 | 0.018 | 3507 | 3535  | 0.019 | 0.001 | 0.001 |
| 551     | Zinc Dialkylthiophosphate                              |   |       |        |        |       |        |       |      |       |       |       |       |
|         | Max.                                                   |   | 1.260 | 27.000 | 79.300 | 0.346 | 1.540  | 0.195 | 5390 | 11501 | 0.204 | 0.010 | 0.011 |
|         | Min.                                                   |   | 0.000 | 0.000  | 1.000  | 0.000 | 1.000  | 0.018 | 3500 | 3499  | 0.019 | 0.000 | 0.000 |

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

# LIQUID TRANSFER RATE vs PRESSURE DROP





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

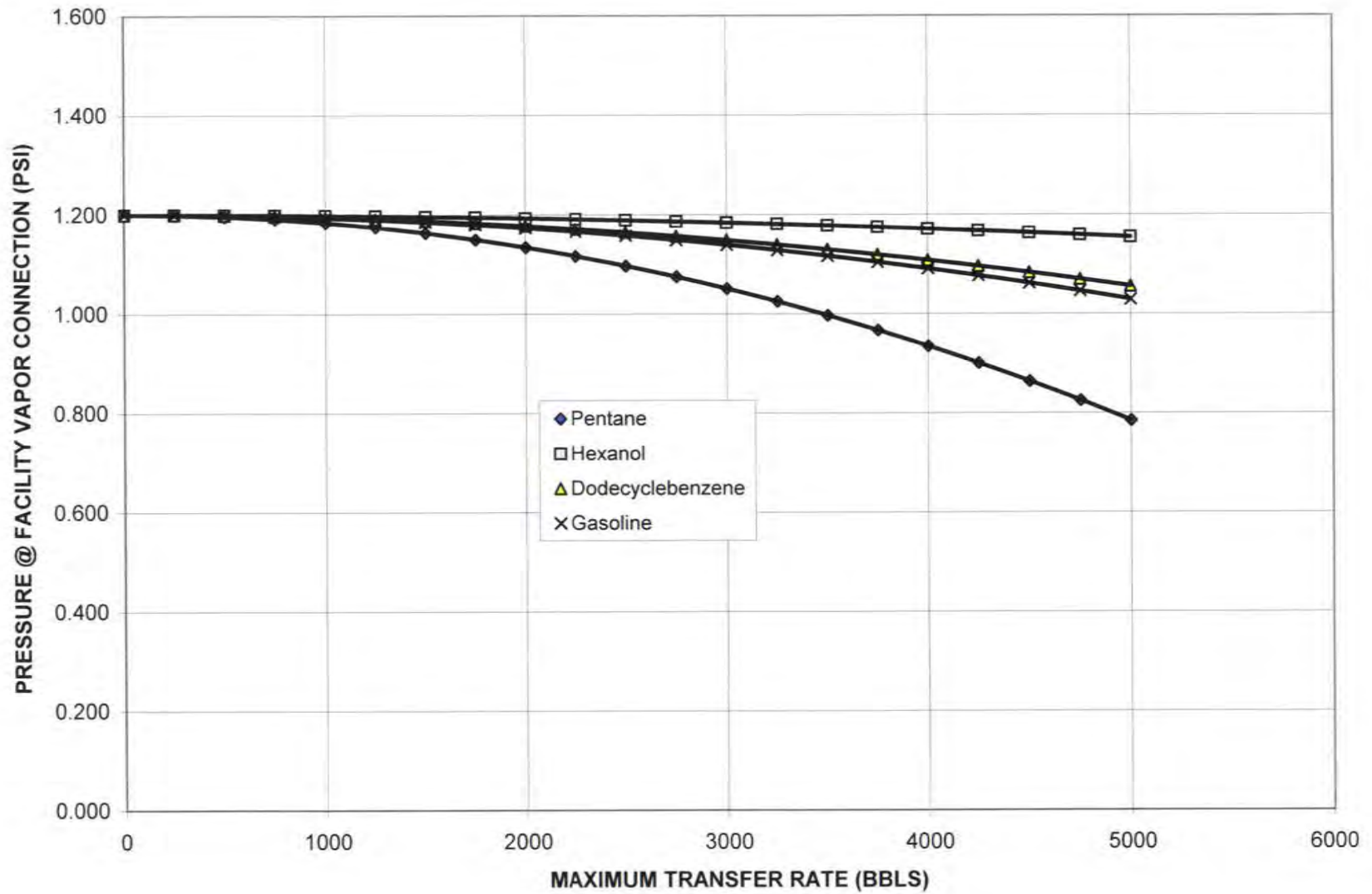
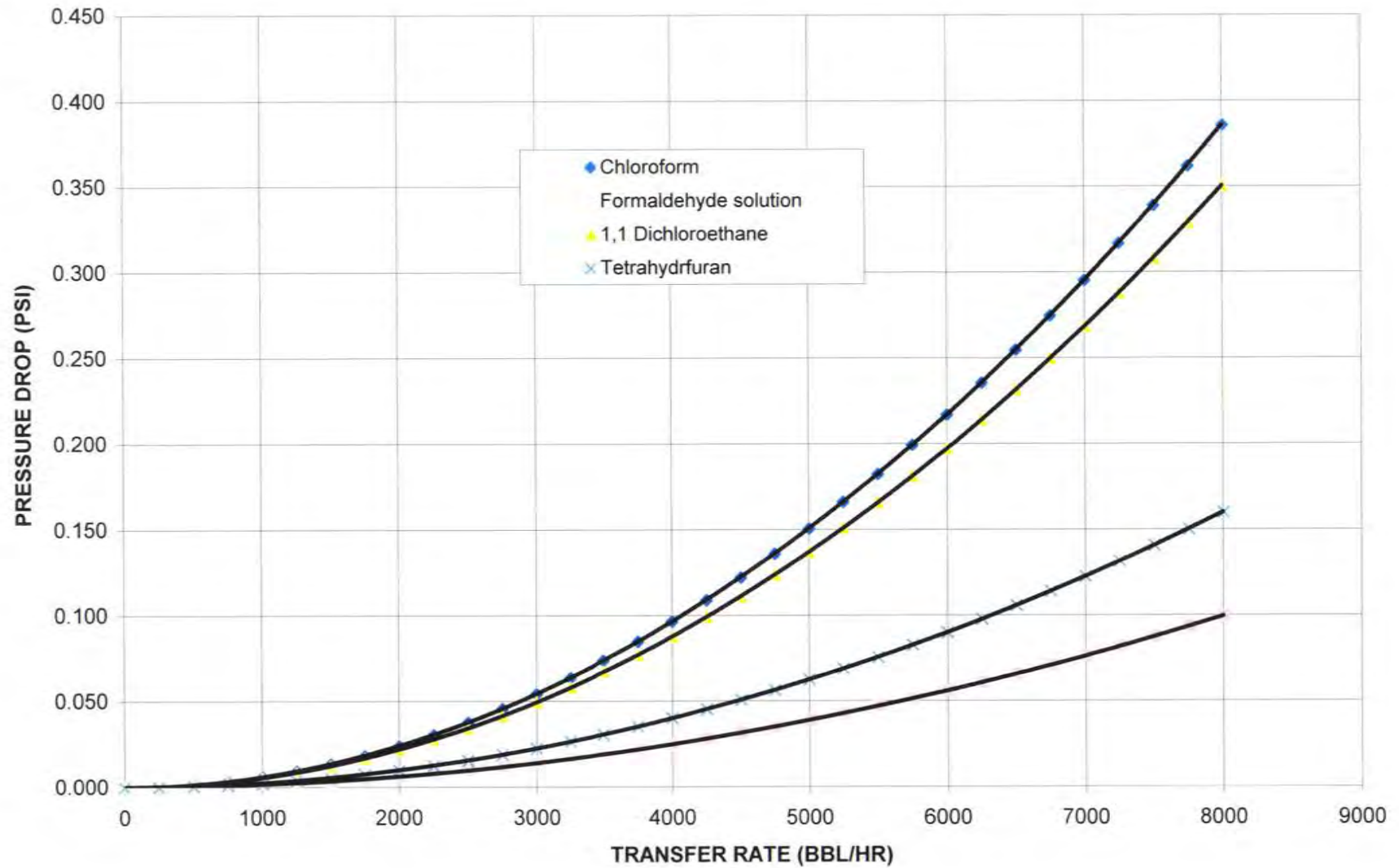


TABLE 4 (SUBCHAPTER "O" CARGOES)

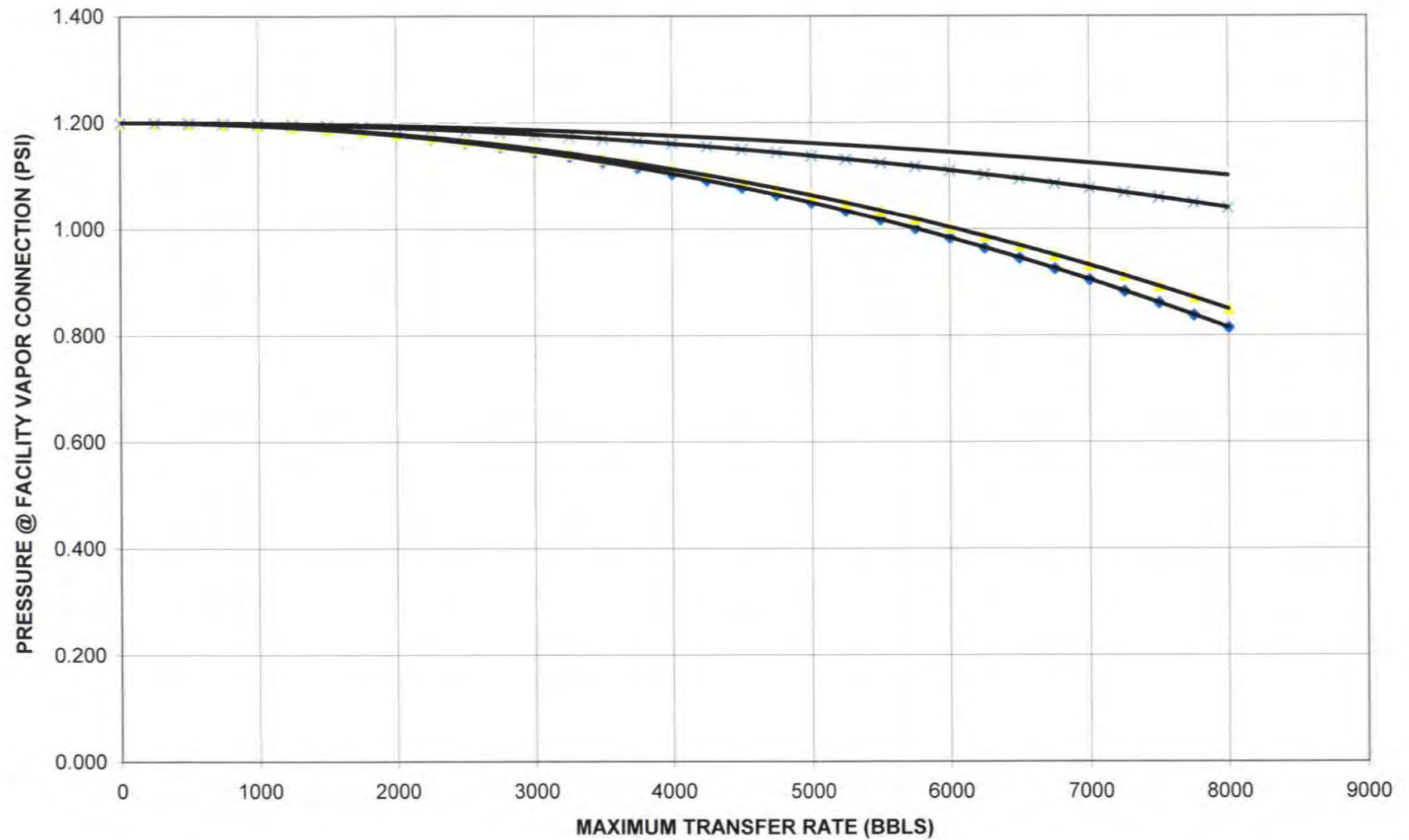
| CHRIS<br>CODE | NAME                                                    | VCS<br>CAT | LIQ<br>SG | VAPOR<br>PRESS | VAPOR<br>SG | VAPOR<br>AIR<br>WEIGHT<br>DENSITY | VAPOR<br>GROWTH<br>RATE | PRESSURE<br>DROP TO PV<br>VALVE IN<br>VCS(psig)<br>(LOADING) | VAPOR<br>VOLUMETRIC<br>FLOW RATE<br>(bbl/h) | AIR<br>EQUIVALENT<br>VOLUMETRIC<br>FLOW RATE | PRESSURE<br>DROP TO<br>SHORE<br>CONNECTION<br>IN VCS (psig)<br>(LOADING)* | PRESSURE<br>DROP TO PV<br>VALVE IN<br>VCS(psig)<br>(UNLOADING) | PRESSURE<br>DROP TO<br>SHORE<br>CONNECTION<br>IN VCS (psig)<br>(UNLOADING)* |
|---------------|---------------------------------------------------------|------------|-----------|----------------|-------------|-----------------------------------|-------------------------|--------------------------------------------------------------|---------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------|-----------------------------------------------------------------------------|
| 1 ACN         | Acrylonitrile                                           | 4          | 0.81      | 5.00           | 1.80        | 0.095                             | 1.1000                  | 0.027                                                        | 3850                                        | 4298                                         | 0.029                                                                     | 0.001                                                          | 0.001                                                                       |
| 2 ADN         | Adiponitrile                                            | 1          | 0.95      | 0.01           | 3.73        | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3503                                         | 0.019                                                                     | 0.001                                                          | 0.001                                                                       |
| 3 ATN         | Acetonitrile                                            | 3          | 0.78      | 0.03           | 1.41        | 0.076                             | 1.0006                  | 0.018                                                        | 3502                                        | 3502                                         | 0.019                                                                     | 0.001                                                          | 0.001                                                                       |
| 4 BAD         | Iso-Butyraldehyde                                       | 1          | 0.80      | 7.80           | 2.50        | 0.131                             | 1.1560                  | 0.041                                                        | 4046                                        | 5308                                         | 0.043                                                                     | 0.002                                                          | 0.002                                                                       |
| 5 BAR         | Butyl acrylate (iso-, n-)                               | 2          | 0.90      | 0.60           | 4.42        | 0.086                             | 1.0120                  | 0.021                                                        | 3542                                        | 3759                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 6 BMH         | Butyl Methacrylate                                      | 2          | 0.88      | 0.29           | 4.9         | 0.081                             | 1.0058                  | 0.019                                                        | 3520                                        | 3640                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 7 BNZ         | Benzene                                                 | 1          | 0.88      | 4.50           | 2.80        | 0.114                             | 1.0900                  | 0.032                                                        | 3815                                        | 4671                                         | 0.034                                                                     | 0.002                                                          | 0.002                                                                       |
| 8 BTR         | n-Butyraldehyde                                         | 1          | 0.80      | 7.80           | 2.50        | 0.131                             | 1.1560                  | 0.041                                                        | 4046                                        | 5308                                         | 0.043                                                                     | 0.002                                                          | 0.002                                                                       |
| 9 BTX         | Benzene, Toluene, Xylene mixtures (10% Benzene or more) | 1          | 0.84      | 7.30           | 2.80        | 0.138                             | 1.1460                  | 0.043                                                        | 4011                                        | 5396                                         | 0.045                                                                     | 0.002                                                          | 0.002                                                                       |
| 10 CCH        | Cyclohexanone                                           | 1          | 0.95      | 0.20           | 3.40        | 0.078                             | 1.0040                  | 0.019                                                        | 3514                                        | 3565                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 11 CHA        | Cyclohexylamine                                         | 1          | 0.87      | 0.62           | 3.42        | 0.083                             | 1.0124                  | 0.020                                                        | 3543                                        | 3703                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 12 CRB        | Chlorobenzene                                           | 1          | 1.11      | 0.80           | 3.88        | 0.087                             | 1.0160                  | 0.021                                                        | 3556                                        | 3799                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 13 CRF        | Chloroform                                              | 3          | 1.48      | 9              | 4.25        | 0.213                             | 1.1800                  | 0.070                                                        | 4130                                        | 6916                                         | 0.074                                                                     | 0.004                                                          | 0.004                                                                       |
| 14 NCT        | Coal Tar Naphtha Solvent                                | 1          | 0.86      | 0.2            | 4           | 0.079                             | 1.0040                  | 0.019                                                        | 3514                                        | 3577                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 15 CRS        | Cresols                                                 | 1          | 1.05      | 0.06           | 3.72        | 0.077                             | 1.0012                  | 0.018                                                        | 3504                                        | 3521                                         | 0.019                                                                     | 0.001                                                          | 0.001                                                                       |
| 16 CTA        | Crotonaldehyde                                          | 4          | 0.85      | 2              | 2.41        | 0.089                             | 1.0400                  | 0.023                                                        | 3640                                        | 3943                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 17 DCH        | 1,1-Dichloroethane                                      | 1          | 1.18      | 9.90           | 3.41        | 0.188                             | 1.1980                  | 0.064                                                        | 4193                                        | 6592                                         | 0.067                                                                     | 0.003                                                          | 0.004                                                                       |
| 18 DPP        | 1,2-Dichloropropane                                     | 3          | 1.16      | 2.5            | 3.89        | 0.110                             | 1.0500                  | 0.029                                                        | 3675                                        | 4418                                         | 0.030                                                                     | 0.001                                                          | 0.002                                                                       |
| 19 DPU        | 1,3-Dichloropropene                                     | 4          | 1.23      | 5.5            | 3.84        | 0.149                             | 1.1100                  | 0.044                                                        | 3885                                        | 5443                                         | 0.046                                                                     | 0.002                                                          | 0.002                                                                       |
| 20 DEN        | Diethylamine                                            | 3          | 0.71      | 1.00           | 2.50        | 0.083                             | 1.0200                  | 0.020                                                        | 3570                                        | 3731                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 21 DIP        | Diisopropanolamine                                      | 1          | 0.98      | 0.01           | 4.59        | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3504                                         | 0.019                                                                     | 0.001                                                          | 0.001                                                                       |
| 22 DMF        | Dimethylformamide                                       | 1          | 0.95      | 0.30           | 2.51        | 0.078                             | 1.0060                  | 0.019                                                        | 3521                                        | 3569                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 23 DPX        | 1,1-, 1,2-, or 1,3-Dichloropropane                      | 3          | 1.16      | 6.30           | 3.90        | 0.162                             | 1.1260                  | 0.049                                                        | 3941                                        | 5747                                         | 0.051                                                                     | 0.003                                                          | 0.003                                                                       |
| 24 EAC        | Ethyl acrylate                                          | 2          | 0.93      | 2.00           | 3.50        | 0.099                             | 1.0400                  | 0.025                                                        | 3640                                        | 4163                                         | 0.027                                                                     | 0.001                                                          | 0.001                                                                       |
| 25 EAI        | 2-Ethylhexyl acrylate                                   | 2          | 0.89      | 0.02           | 6.35        | 0.076                             | 1.0004                  | 0.018                                                        | 3501                                        | 3512                                         | 0.019                                                                     | 0.001                                                          | 0.001                                                                       |
| 26 EDC        | Ethylene dichloride                                     | 1          | 1.26      | 4.00           | 3.42        | 0.121                             | 1.0800                  | 0.034                                                        | 3780                                        | 4776                                         | 0.035                                                                     | 0.002                                                          | 0.002                                                                       |
| 27 ETM        | Ethyl Methacrylate                                      | 2          | 0.92      | 1              | 3.94        | 0.090                             | 1.0200                  | 0.022                                                        | 3570                                        | 3879                                         | 0.023                                                                     | 0.001                                                          | 0.001                                                                       |
| 28 EPA        | 2-Ethyl-3-propylacrolein                                | 1          | 0.85      | 0.12           | 4.5         | 0.078                             | 1.0024                  | 0.019                                                        | 3508                                        | 3553                                         | 0.019                                                                     | 0.001                                                          | 0.001                                                                       |
| 29 FFA        | Furfural                                                | 1          | 1.20      | 0.15           | 3.31        | 0.078                             | 1.0030                  | 0.019                                                        | 3511                                        | 3547                                         | 0.019                                                                     | 0.001                                                          | 0.001                                                                       |
| 30 FMS        | Formaldehyde solution (37% to 50%)                      | 1          | 1.13      | 0.15           | 1.03        | 0.076                             | 1.0030                  | 0.018                                                        | 3511                                        | 3510                                         | 0.019                                                                     | 0.001                                                          | 0.001                                                                       |
| 31 MSO        | Mesityl Oxide                                           | 1          | 0.86      | 0.67           | 3.5         | 0.084                             | 1.0134                  | 0.020                                                        | 3547                                        | 3725                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 32 MAM        | Methyl acrylate                                         | 2          | 0.95      | 4.10           | 3.00        | 0.114                             | 1.0820                  | 0.032                                                        | 3787                                        | 4646                                         | 0.033                                                                     | 0.002                                                          | 0.002                                                                       |
| 33 MBE        | Methylcyclopentadiene dimer                             | 1          | 0.74      | 0.04           | 3.10        | 0.076                             | 1.0008                  | 0.018                                                        | 3503                                        | 3511                                         | 0.019                                                                     | 0.001                                                          | 0.001                                                                       |
| 34 MMM        | Methyl methacrylate                                     | 2          | 0.94      | 2.02           | 3.45        | 0.099                             | 1.0404                  | 0.025                                                        | 3641                                        | 4159                                         | 0.027                                                                     | 0.001                                                          | 0.001                                                                       |
| 35 MPL        | Morpholine                                              | 1          | 1.00      | 0.80           | 3.00        | 0.083                             | 1.0160                  | 0.020                                                        | 3556                                        | 3726                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 36 NPM        | 1- or 2-Nitropropane                                    | 1          | 0.99      | 1.05           | 3.06        | 0.086                             | 1.0210                  | 0.021                                                        | 3574                                        | 3804                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 37 PRD        | Pyridine                                                | 1          | 0.98      | 1.30           | 2.72        | 0.086                             | 1.0260                  | 0.022                                                        | 3591                                        | 3830                                         | 0.023                                                                     | 0.001                                                          | 0.001                                                                       |
| 38 STY        | Styrene                                                 | 2          | 0.92      | 0.40           | 3.60        | 0.081                             | 1.0080                  | 0.019                                                        | 3528                                        | 3638                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 39 TCN        | 1,2,3-Trichloropropane                                  | 3          | 1.39      | 0.15           | 5.60        | 0.079                             | 1.0030                  | 0.019                                                        | 3511                                        | 3583                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 40 TEN        | Triethylamine                                           | 3          | 0.73      | 2.50           | 3.49        | 0.105                             | 1.0500                  | 0.027                                                        | 3675                                        | 4323                                         | 0.029                                                                     | 0.001                                                          | 0.002                                                                       |
| 41 THF        | Tetrahydrofuran                                         | 1          | 0.89      | 8.50           | 1.35        | 0.090                             | 1.1700                  | 0.029                                                        | 4095                                        | 4454                                         | 0.031                                                                     | 0.002                                                          | 0.002                                                                       |
| 42 VAM        | Vinyl acetate                                           | 2          | 0.94      | 5.80           | 2.97        | 0.130                             | 1.1160                  | 0.038                                                        | 3906                                        | 5099                                         | 0.040                                                                     | 0.002                                                          | 0.002                                                                       |
|               |                                                         | Max.       | 1.39      | 12.5           | 8.40        | 0.213                             | 1.198                   | 0.070                                                        | 4193                                        | 6916                                         | 0.074                                                                     | 0.004                                                          | 0.004                                                                       |
|               |                                                         | Min.       | 0.63      | 0.01           | 1.03        | 0.076                             | 1.000                   | 0.018                                                        | 3501                                        | 3502                                         | 0.019                                                                     | 0.001                                                          | 0.001                                                                       |

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

## LIQUID TRANSFER RATE vs PRESSURE DROP



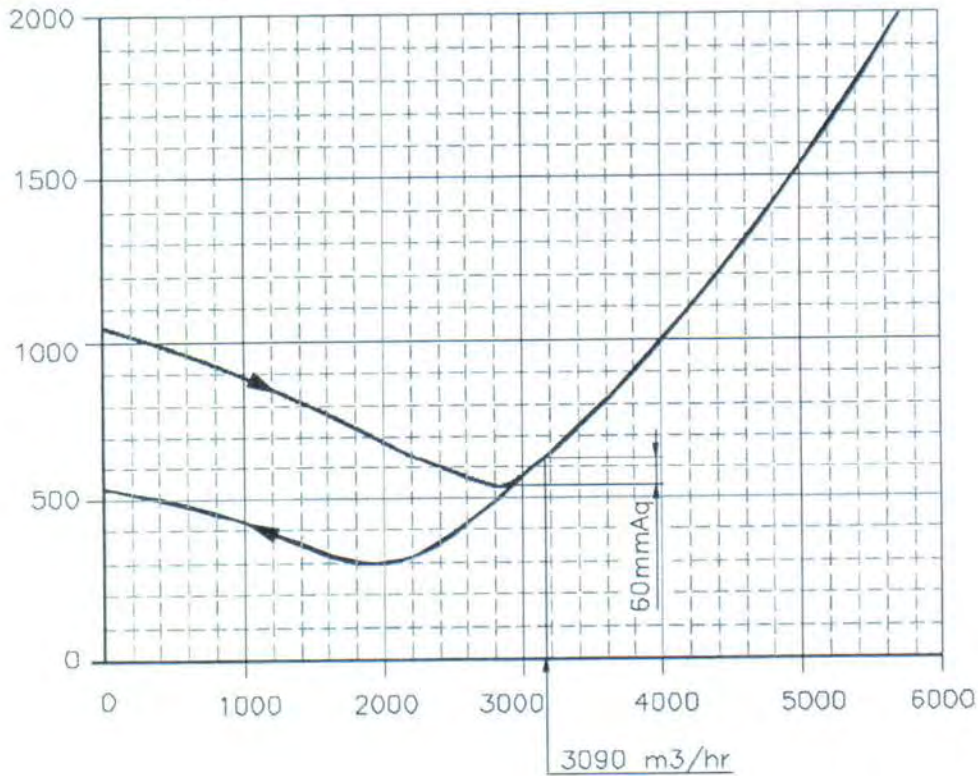
# PRESSURE vs MAXIMUM TRANSFER RATE (FOR SUB-CHAPTER "O" CARGOES)



# HIGH VELOCITY VENT VALVE FLOW CAPACITY CURVE

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

VALVE INLET PRESSURE, mmAq  
 (1mmAq = 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> |               |

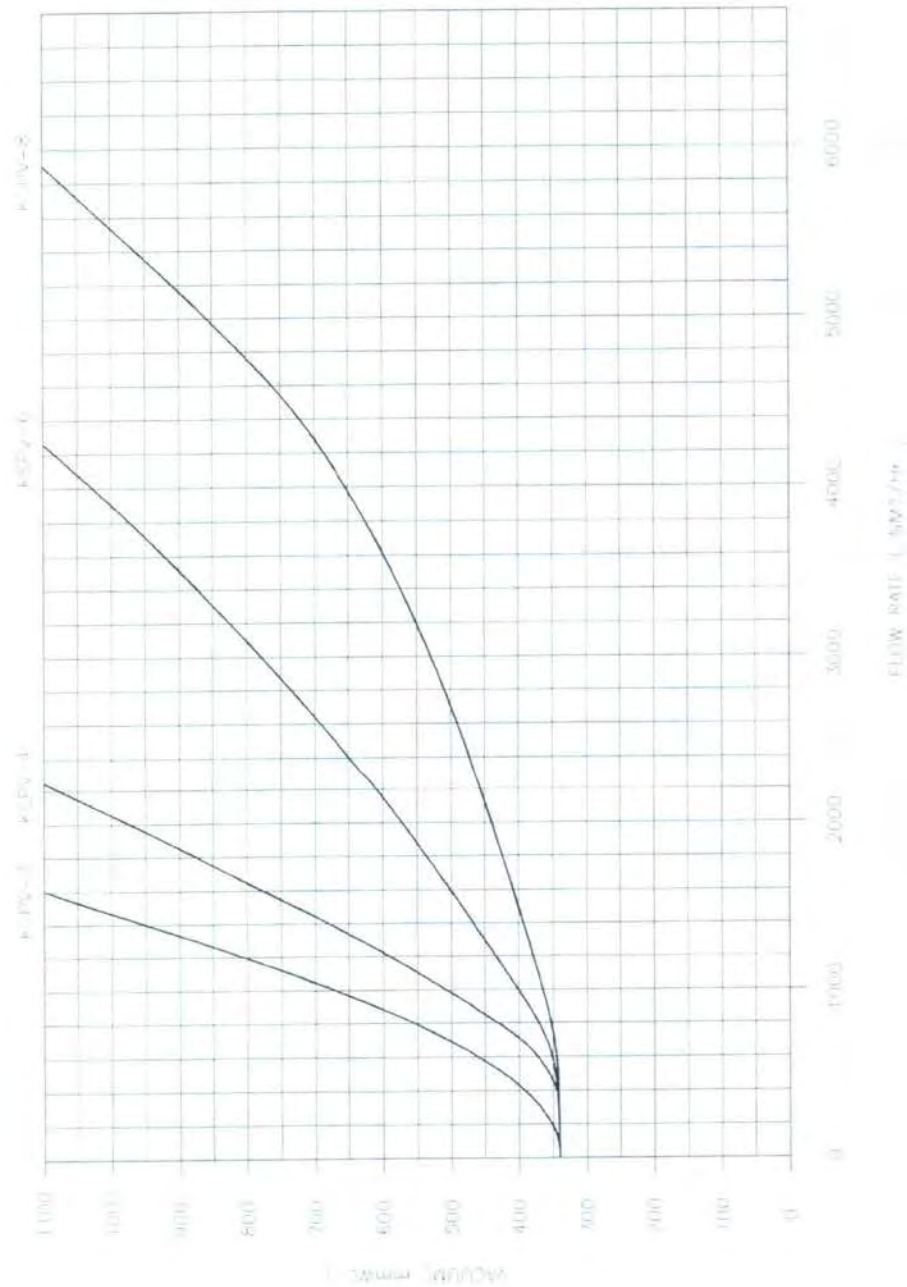
NEW ISO-HV-series flow capacity curve

FILEPOSITION: PC02-//D//15 flow.doc



# FLOW CAPACITY CURVE GRAPH

FLOW TEST PERFORMED ON EQUIPMENT  
USING AIR, AT TEMP. 1-15 °C AND  
AMBIENT PRESSURE P=1.0332 kg/cm<sup>2</sup>



TANKTECH

TITLE HIGH VELOCITY VACUUM RELIEF VALVE  
KSPV TYPE



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



|                    |                                                                                                                          |             |                    |
|--------------------|--------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|
| Vessel Name        | CBC 1390 thru CBC 1399                                                                                                   | Shipyard    | Southwest Shipyard |
| Coast Guard Number | CG1429762, CG1429764,<br>CG1429765, CG1429767,<br>CG1429768, CG1429769,<br>CG1429771, CG1432241,<br>CG1432242, CG1432243 | Hull Number | 9768 thru 9777     |

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

|                                                 |                                                                                |                                                  |                                     |
|-------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------|-------------------------------------|
| 2. Tank Maximum Design Working Pressure         | <input type="text" value="3.50"/> psig                                         | Raised Trunk <input checked="" type="checkbox"/> | Flush Deck <input type="checkbox"/> |
| 3. Authorized Maximum Cargo Transfer Rate(s)    | <input type="text" value="3,500"/> bbl/hr loading (max 2 tanks simultaneously) |                                                  |                                     |
|                                                 | <input type="text" value="800"/> bbl/hr discharging                            |                                                  |                                     |
| 4. Authorized Maximum Vapor-Air Mixture Density | <input type="text" value="0.346"/> lbm/ft <sup>3</sup>                         |                                                  |                                     |
| 5. Authorized VCS Categories                    | <input type="text" value="1 through 5"/>                                       |                                                  |                                     |

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

a. Cargo Name Pentane (all isomers) [PTY]

7. Pressure Vacuum Valve:

|              |               |
|--------------|---------------|
| Manufacturer | Bergan        |
| Size         | KLPH-6        |
| CG Approval  | 162.017/144/3 |

Settings in psig:

|               |                                  |
|---------------|----------------------------------|
| Pressure-side | <input type="text" value="1.5"/> |
| Vacuum-side   | <input type="text" value="0.5"/> |

8. VCS Pipe Sizes:

|                              |                                |
|------------------------------|--------------------------------|
| Approx. Inside Diameter      |                                |
| Longitudinal Header (inches) | <input type="text" value="8"/> |
| Transverse Header (Inches)   | <input type="text" value="8"/> |

|                                                         |                                                |
|---------------------------------------------------------|------------------------------------------------|
| Required Venting Capacity of Pressure-Side of P/V valve | <input type="text" value="9337"/> bbl/hr (air) |
| Required Venting Capacity of Vacuum-Side of P/V valve   | <input type="text" value="800"/> bbl/hr (air)  |

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

|                                   |                                     |      |                                     |                  |                                                     |
|-----------------------------------|-------------------------------------|------|-------------------------------------|------------------|-----------------------------------------------------|
| a. High Level/Tank Overfill Alarm | <input checked="" type="checkbox"/> | Type | <input type="text" value="Bergan"/> | Meets ASTM F1271 | Setting in psig<br><input type="text" value="N/A"/> |
| b. Overfill Control Shutdown      | <input checked="" type="checkbox"/> | Type | <input type="text" value="Bergan"/> |                  |                                                     |
| c. Spill Valve                    | <input type="checkbox"/>            | Type | <input type="text" value="N/A"/>    |                  |                                                     |
| d. Rupture Disk                   | <input type="checkbox"/>            | Type | <input type="text" value="N/A"/>    |                  |                                                     |

10. Closed Gauging Verify the vessel has closed gauging that satisfies 46 CFR 39.2003 and 151.15-10(c).

11. Instructions/Guidelines for the OCMI:

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

In accordance with 46 CFR Part 39, excluding part 39.4000, this vessel's vapor collection system has been inspected to the plans approved by MSC Letter C1-1700672 dated February 28, 2017, and has been found acceptable for the collection of bulk liquid cargo vapors annotated with "Yes" in the CAA's VCS column of the vessel's Cargo Authority Attachment. The VCS system has been approved with a pressure side 1.5 psig P/V valve with Coast Guard Approval 162.017/144/3. The cargo tank top is suitable for a maximum allowable working pressure (MAWP) of 3.5 psi. When the vessel is carrying cargoes containing greater than 0.5% benzene, the person in charge is responsible for ensuring the provisions of 46 US Code of Federal Regulations Part 197, Subpart C are applied.

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

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

|                     |                                               |                   |                    |
|---------------------|-----------------------------------------------|-------------------|--------------------|
| VCS Approval Letter | MSC Letter C1-1700672 dated February 28, 2017 | MSC Plan Reviewer | LT M. P. Comerford |
|---------------------|-----------------------------------------------|-------------------|--------------------|