



# MARINE SOLUTIONS, Inc.

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E-mail  
MSI/121401/S03

March 28, 2015

Attn: Chief-Tank Vessel Offshore Branch  
United States Coast Guard,  
Marine Safety Center,  
4200 Wilson Blvd., Suite 400, STOP 7410  
Arlington, VA 20598-7410

Sub: 200'-0" x 35' x 12'-6" Double Skin Tank Barges (O/D)  
Barge Name(S): CBC 1380 THRU CBC1387  
Southwest Shipyard Hull(S): 9739 THRU 9746  
Plan Submittal

Encl.: 1. Dwg. No. 121401VP-1, SH 1 of 2, Rev 1 "Vapor Piping"  
2. Dwg. No. 121401VP-1, SH 2 of 2, Rev 1 "Vapor Piping"  
3. Vapor Recovery Calculations  
4. VCS Form

Ref: 1. USCG Project P018455

Dear Commanding Officer:

As a technical agent of the Southwest Shipyard, Houston, TX, We are submitting enclosures 1 thru 4 for your review and approval.

The MSO-Galveston, TX is inspecting these barges.

The barge will be certificate for carriage of Subchapter D, Grade A and lower cargoes with limited Subchapter O cargoes.

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

cc: Mr. Josh Roy-Project Manager, Southwest Shipyard, L.P.

Marine Solution Inc., P.O. Box 218197, TN 37221-8197  
Tel: 615-364-9598 Fax: 615-662-9608  
[Marinesolinc@aol.com](mailto:Marinesolinc@aol.com)

**VAPOR COLLECTION SYSTEM CALCULATIONS**

**FOR**

**BARGE NAME(s): "CBC 1380" thru "CBC 1387"**

**SOUTHWEST SHIPYARD HULL(s): 9739 thru 9746**

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

**CANAL BARGE COMPANY, INC.**

**March 28, 2015**

**Prepared by:**

A handwritten signature in black ink, appearing to read 'Kumaria', with a stylized flourish at the end.

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

# MARINE SOLUTIONS, INC.

Rev. 0 dated March 28, 2015

## VCS SYSTEM INFORMATION:

### 1. GENERAL DESCRIPTION OF VESSEL:

A. NAME (S): CBC 1380 THRU CBC 1387  
B. USCG PROJECT NUMBER: P018455  
C. DIMENSIONS: 200'-0" X 35'-0" X 12'-6"  
D. SERVICE: TANK BARGE (O/D)  
E. MAX. DESIGN WORKING PRESSURE: 3.5 PSIG  
F. PV VALVE PRESSURE SETTING: 1 PSIG  
G. PV VALVE VACUUM SETTING: 0.5 PSIG  
H. MAX. DISCHARGE RATE: 800 BBL/HR

### 2. VAPOR CONTROL SYSTEM

A. PIPE DIAMETER: 7.981 INCHES IPS  
B. PIPE LENGTHS: A- 1'-7 1/4" B-3'-5 7/8" C-53'-2 23/64" D-8'-1 39/64", E-34'-2 3/64"  
F- 48'-9 15/16" G-1'-9 19/232" H-4'-1 1/4" J-9'-6 7/8"

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

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

#### D. SPILL VALVE RELIEVING CAPACITY:

NON INSTALLED

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

0.335 LBM/FT<sup>3</sup> FOR SUB D

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

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

3500 BBL/HR

#### G. DARCY FRICTION FACTOR:

0.014

#### H. VCS CARGOES:

SEE TABLE 1 & TABLE 4

#### I. ADDITIONAL MIS. INFORMATION:

SYSTEM IS DESIGNED TO ACCOMMODATE INTERNAL VISUAL INSPECTION.

## VCS CALCULATIONS

### 1. CARGO AUTHORITY::

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

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

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

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

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

TABLE 2

| PIPE/FITTINGS | QUANTITY | UNIT EQ.<br>LENGTH (FT) | TOTAL EQ.<br>LENGTH (FT) |
|---------------|----------|-------------------------|--------------------------|
| Straight Pipe | 1        | 63.015                  | 63.015                   |
| 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                   | 379.385                  |

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

Using a 3500 bbl/h liquid transfer rate, the vapor-air mixture and air-equivalent volumetric flow rate for each cargo are given in Table 1 & Table 4. At a setting of 1.0 psig, the Bergan KLPH-6 PV Valve has an adequate pressure relieving capacity of air for each cargo listed in Table 1 & Table 4. The greatest pressure drop in the venting system (1.169 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        | 161.495                 | 161.495                  |
| Entrance      | 1        | 37.05                   | 37.05                    |
| T Branch      | 4        | 39.91                   | 159.64                   |
| T Run         | 8        | 13.33                   | 106.64                   |
| 8" Gate Valve | 1        | 5.32                    | 5.32                     |
|               |          | Total                   | 470.145                  |

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

TABLE 1 (SUB CHAPTER "D" CARGOES)

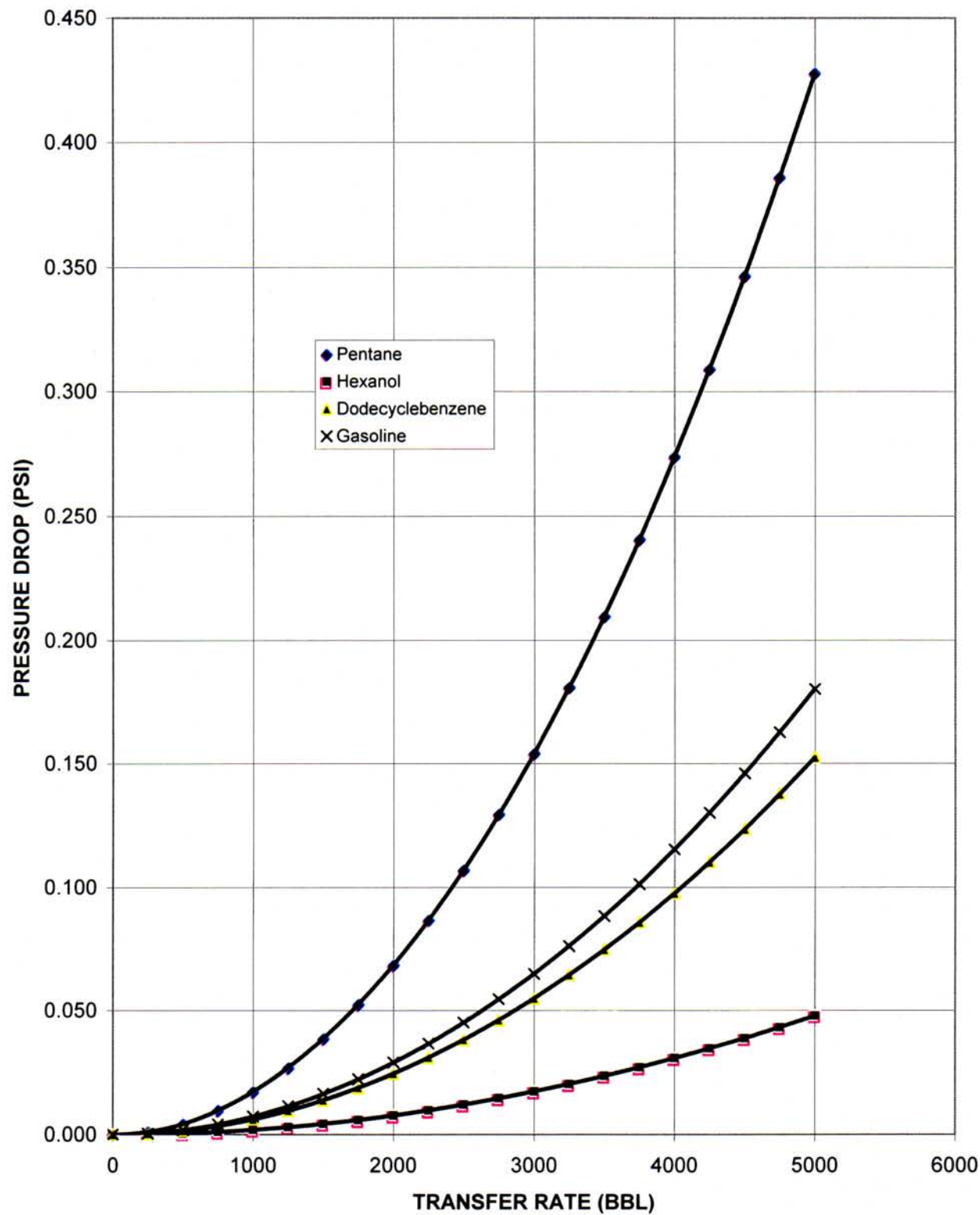
| CHRIS<br>CODE | NAME                                                  | VCS<br>CAT | LIQ<br>SG | VAPOR<br>PRESS | VAPOR<br>SG | VAPOR<br>AIR<br>WEIGHT<br>DENSITY | VAPOR<br>GROWTH<br>RATE | PRESSURE<br>DROP TO PV<br>VALVE IN<br>VCS (psig)<br>(LOADING) | VAPOR<br>VOLUMETRIC<br>FLOW RATE<br>(bbl/h) | 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           | 0.121                             | 1.2000                  | 0.037                                                         | 4200                                        | 5372                                         | 0.046                                                                     | 0.002                                                           | 0.002                                                                       |
| 2 ACP         | Acetophenone                                          | 1          | 1.03      | 0.6            | 4.14        | 0.082                             | 1.0120                  | 0.018                                                         | 3542                                        | 3747                                         | 0.022                                                                     | 0.001                                                           | 0.001                                                                       |
| 19 AAT        | Amyl Acetate (iso-)                                   | 1          | 0.88      | 0.33           | 4.48        | 0.079                             | 1.0066                  | 0.017                                                         | 3523                                        | 3649                                         | 0.021                                                                     | 0.001                                                           | 0.001                                                                       |
| 20 AAI        | Amyl Alcohol (iso-, n-, sec-, primary) (See also IAA) | 1          | 0.82      | 0.3            | 3.04        | 0.077                             | 1.0060                  | 0.016                                                         | 3521                                        | 3588                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 21 AAN        | Amyl Alcohol (n-)                                     | 1          | 0.82      | 0.3            | 3.04        | 0.077                             | 1.0060                  | 0.016                                                         | 3521                                        | 3588                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 23 APM        | Amyl Alcohol, Primary                                 | 1          | 0.82      | 0.3            | 3.04        | 0.077                             | 1.0060                  | 0.016                                                         | 3521                                        | 3588                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 24 ASE        | Amyl Alcohol, (sec-)                                  | 1          | 0.82      | 0.3            | 3.04        | 0.077                             | 1.0060                  | 0.016                                                         | 3521                                        | 3588                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 26 IAA        | Amyl Alcohol, (iso-)                                  | 1          | 0.82      | 0.3            | 3.04        | 0.077                             | 1.0060                  | 0.016                                                         | 3521                                        | 3588                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 34 BAL        | Benzyl Alcohol                                        | 1          | 1.05      | 0.1            | 3.73        | 0.075                             | 1.0020                  | 0.016                                                         | 3507                                        | 3536                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 40 BAX        | Butyl Acetate (iso-, n-)                              | 1          | 0.87      | 0.6            | 4           | 0.082                             | 1.0120                  | 0.018                                                         | 3542                                        | 3738                                         | 0.022                                                                     | 0.001                                                           | 0.001                                                                       |
| 42 BTA        | Butyl Acetate (sec-)                                  | 1          | 0.89      | 1.5            | 4           | 0.095                             | 1.0300                  | 0.021                                                         | 3605                                        | 4088                                         | 0.026                                                                     | 0.001                                                           | 0.001                                                                       |
| 44 IAL        | Butyl Alcohol (iso-)                                  | 1          | 0.81      | 0.9            | 2.6         | 0.080                             | 1.0180                  | 0.018                                                         | 3563                                        | 3722                                         | 0.022                                                                     | 0.001                                                           | 0.001                                                                       |
| 46 BAS        | Butyl Alcohol (sec-)                                  | 1          | 0.81      | 1.3            | 2.6         | 0.083                             | 1.0260                  | 0.019                                                         | 3591                                        | 3820                                         | 0.023                                                                     | 0.001                                                           | 0.001                                                                       |
| 47 BAT        | Butyl Alcohol (tert-)                                 | 1          | 0.78      | 2.8            | 2.6         | 0.095                             | 1.0560                  | 0.022                                                         | 3696                                        | 4189                                         | 0.028                                                                     | 0.001                                                           | 0.001                                                                       |
| 48 BPH        | Butyl Benzyl Phthalate                                | 1          | 1.12      | 0.01           | 10.8        | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3511                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 64 CLS        | Caprolactam Solutions                                 | 1          | 1.02      | 0.05           | 3.9         | 0.074                             | 1.0010                  | 0.016                                                         | 3504                                        | 3519                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 70 CUM        | Cumene                                                | 1          | 0.86      | 0.60           | 4.20        | 0.083                             | 1.0120                  | 0.018                                                         | 3542                                        | 3751                                         | 0.022                                                                     | 0.001                                                           | 0.001                                                                       |
| 72 CHX        | Cyclohexane                                           | 1          | 0.78      | 4.5            | 2.9         | 0.114                             | 1.0900                  | 0.029                                                         | 3815                                        | 4740                                         | 0.036                                                                     | 0.002                                                           | 0.002                                                                       |
| 73 CHN        | Cyclohexanol                                          | 1          | 0.95      | 0.15           | 3.45        | 0.075                             | 1.0030                  | 0.016                                                         | 3511                                        | 3550                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 74 CPD        | 1,3-Cyclopentadiene dimer (molten)                    | 1          | 0.69      | 0.25           | 4.55        | 0.078                             | 1.0050                  | 0.017                                                         | 3518                                        | 3615                                         | 0.021                                                                     | 0.001                                                           | 0.001                                                                       |
| 76 CMP        | Cymene (para-)                                        | 1          | 0.86      | 0.11           | 4.62        | 0.076                             | 1.0022                  | 0.016                                                         | 3508                                        | 3551                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 77 DHN        | Decahydronaphthalene                                  | 1          | 0.89      | 0.1            | 4.76        | 0.075                             | 1.0020                  | 0.016                                                         | 3507                                        | 3548                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 78 IDA        | Decaldehyde (iso-)                                    | 1          | 0.83      | 0.01           | 5           | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3504                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 79 DAL        | Decaldehyde (n-)                                      | 1          | 0.83      | 0              | 5.01        | 0.074                             | 1.0000                  | 0.016                                                         | 3500                                        | 3499                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 81 DCE        | Decane                                                | 1          | 0.74      | 0.12           | 4.8         | 0.076                             | 1.0024                  | 0.016                                                         | 3508                                        | 3558                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 82 DAX        | Decyl Alcohol (all isomers) (Decanol)                 | 1          | 0.83      | 0.01           | 5.3         | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3505                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 83 ISA        | Decyl Alcohol (iso-)                                  | 1          | 0.83      | 0.01           | 5.3         | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3505                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 84 DAN        | Decyl Alcohol (n-)                                    | 1          | 0.83      | 0.01           | 5.3         | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3505                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 85 DBZ        | Decylbenzene (n-)                                     | 1          | 0.86      | 0.01           | 7.52        | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3507                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 87 DAA        | Diacetone Alcohol                                     | 1          | 0.97      | 0.1            | 4           | 0.075                             | 1.0020                  | 0.016                                                         | 3507                                        | 3539                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 91 DPA        | Dibutyl Phthalate (ortho-)                            | 1          | 1.05      | 0              | 9.59        | 0.074                             | 1.0000                  | 0.016                                                         | 3500                                        | 3499                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 92 DPT        | Dicyclopentadiene, See 1,3-Cyclopentadiene Dimer      | 2          | 0.98      | 0.25           | 4.55        | 0.078                             | 1.0050                  | 0.017                                                         | 3518                                        | 3615                                         | 0.021                                                                     | 0.001                                                           | 0.001                                                                       |
| 93 DEB        | Diethylbenzene                                        | 1          | 0.87      | 0.08           | 4.62        | 0.075                             | 1.0016                  | 0.016                                                         | 3506                                        | 3537                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 94 DEG        | Diethylene Glycol                                     | 1          | 1.12      | 0.01           | 3.66        | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3503                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 95 DME        | Diethylene Glycol Butyl Ether                         | 1          | 0.95      | 0.01           | 5.5         | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3505                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 100 DGA       | Diethylene Glycol Ethyl Ether Acetate                 | 1          | 0.99      | 0.02           | 4.62        | 0.074                             | 1.0004                  | 0.016                                                         | 3501                                        | 3508                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 101 DGM       | Diethylene Glycol Methyl Ether                        | 1          | 1.03      | 0.03           | 4.14        | 0.074                             | 1.0006                  | 0.016                                                         | 3502                                        | 3512                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 111 DBC       | Diisobutylcarbinol                                    | 1          | 0.81      | 0.09           | 4.97        | 0.075                             | 1.0018                  | 0.016                                                         | 3506                                        | 3545                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 112 DBL       | Diisobutylene                                         | 1          | 0.72      | 2              | 3.86        | 0.100                             | 1.0400                  | 0.023                                                         | 3640                                        | 4251                                         | 0.029                                                                     | 0.001                                                           | 0.001                                                                       |
| 113 DIX       | Diisobutyl Ketone                                     | 1          | 0.81      | 0.16           | 4.9         | 0.077                             | 1.0032                  | 0.016                                                         | 3511                                        | 3579                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 119 DIX       | Diisopropylbenzene (all isomer)                       | 1          | 0.86      | 0.03           | 5.6         | 0.074                             | 1.0006                  | 0.016                                                         | 3502                                        | 3516                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 124 DTL       | Dimethyl Phthalate                                    | 1          | 1.19      | 0              | 6.69        | 0.074                             | 1.0000                  | 0.016                                                         | 3500                                        | 3499                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 130 DOP       | Diocetyl Phthalate                                    | 1          | 0.98      | 0              | 13.47       | 0.074                             | 1.0000                  | 0.016                                                         | 3500                                        | 3499                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 131 DPN       | Dipentene                                             | 1          | 0.84      | 0.1            | 4.9         | 0.075                             | 1.0020                  | 0.016                                                         | 3507                                        | 3549                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 132 DIL       | Diphenyl                                              | 1          | 0.99      | 0.01           | 5.31        | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3505                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 133 DDO       | Diphenyl, Diphenyl Ether Mixture                      | 1          | 1.07      | 0.01           | 5.86        | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3505                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 134 DPE       | Diphenyl Ether                                        | 1          | 1.07      | 0.01           | 5.87        | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3505                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 136 DPG       | Dipropylene Glycol                                    | 1          | 1.03      | 0.07           | 4.63        | 0.075                             | 1.0014                  | 0.016                                                         | 3505                                        | 3532                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 139 DFF       | Distillates: Flashed Feed Stocks                      | 1          | 0.75      | 2.3            | 3.4         | 0.100                             | 1.0460                  | 0.023                                                         | 3661                                        | 4255                                         | 0.029                                                                     | 0.001                                                           | 0.001                                                                       |
| 140 DSR       | Distillates: Straight Run                             | 1          | 0.73      | 2.3            | 3.4         | 0.100                             | 1.0460                  | 0.023                                                         | 3661                                        | 4255                                         | 0.029                                                                     | 0.001                                                           | 0.001                                                                       |
| 145 DOZ       | Dodecene (all isomers)                                | 1          | 0.76      | 0.02           | 5.81        | 0.074                             | 1.0004                  | 0.016                                                         | 3501                                        | 3511                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 146 DOD       | Dodecene                                              | 1          | 0.76      | 0.02           | 5.81        | 0.074                             | 1.0004                  | 0.016                                                         | 3501                                        | 3511                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 147 DDB       | Dodecylbenzene                                        | 1          | 0.86      | 4.7            | 8.4         | 0.237                             | 1.0940                  | 0.060                                                         | 3829                                        | 6864                                         | 0.075                                                                     | 0.003                                                           | 0.004                                                                       |
| 155 ETG       | Ethoxy Triglycol (crude)                              | 1          | 1.02      | 0              | 6.14        | 0.074                             | 1.0000                  | 0.016                                                         | 3500                                        | 3499                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 156 ETA       | Ethyl Acetate                                         | 1          | 0.9       | 4.5            | 3.04        | 0.117                             | 1.0900                  | 0.029                                                         | 3815                                        | 4801                                         | 0.037                                                                     | 0.002                                                           | 0.002                                                                       |
| 157 EAA       | Ethyl Acetoacetate                                    | 1          | 1.03      | 0.2            | 4.48        | 0.077                             | 1.0040                  | 0.016                                                         | 3514                                        | 3590                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 158 EAL       | Ethyl Alcohol (Ethanol)                               | 1          | 0.79      | 3.5            | 1.6         | 0.083                             | 1.0700                  | 0.020                                                         | 3745                                        | 3986                                         | 0.025                                                                     | 0.001                                                           | 0.001                                                                       |
| 160 ETB       | Ethyl Benzene                                         | 1          | 0.87      | 0.6            | 3.56        | 0.081                             | 1.0120                  | 0.018                                                         | 3542                                        | 3710                                         | 0.022                                                                     | 0.001                                                           | 0.001                                                                       |
| 161 EBT       | Ethyl Butanol                                         | 1          | 0.83      | 0.12           | 3.52        | 0.075                             | 1.0024                  | 0.016                                                         | 3508                                        | 3541                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |
| 162 EBR       | Ethyl Butyrate                                        | 1          | 0.88      | 1              | 4           | 0.088                             | 1.0200                  | 0.019                                                         | 3570                                        | 3895                                         | 0.024                                                                     | 0.001                                                           | 0.001                                                                       |
| 163 ECY       | Ethyl Cyclohexane                                     | 1          | 0.79      | 0.5            | 3.87        | 0.080                             | 1.0100                  | 0.017                                                         | 3535                                        | 3692                                         | 0.022                                                                     | 0.001                                                           | 0.001                                                                       |
| 166 EGL       | Ethylene Glycol                                       | 1          | 1.19      | 0.01           | 2.21        | 0.074                             | 1.0002                  | 0.016                                                         | 3501                                        | 3501                                         | 0.019                                                                     | 0.001                                                           | 0.001                                                                       |
| 169 EMA       | Ethylene Glycol Butyl Ether Acetate                   | 1          | 0.94      | 0.05           | 5.52        | 0.075                             | 1.0010                  | 0.016                                                         | 3504                                        | 3528                                         | 0.020                                                                     | 0.001                                                           | 0.001                                                                       |

|     |     |                                                        |   |      |       |      |       |        |       |      |      |       |       |       |
|-----|-----|--------------------------------------------------------|---|------|-------|------|-------|--------|-------|------|------|-------|-------|-------|
| 172 | EGY | Ethylene Glycol Diacetate                              | 1 | 1.1  | 0.01  | 5.03 | 0.074 | 1.0002 | 0.016 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 178 | EME | Ethylene Glycol Methyl Ether                           | 1 | 1.1  | 0.01  | 4.8  | 0.074 | 1.0002 | 0.016 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 180 | EPE | Ethylene Glycol Phenyl Ether                           | 1 | 1.1  | 0.01  | 4.8  | 0.074 | 1.0002 | 0.016 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 184 | EHA | 2-Ethylhexaldehyde, See Octyl Aldehydes                | 1 | 0.82 | 0.17  | 4.41 | 0.076 | 1.0034 | 0.016 | 3512 | 3575 | 0.020 | 0.001 | 0.001 |
| 186 | EHX | 2-Ethylhexanol, see Octanol (all isomers)              | 1 | 0.84 | 0.02  | 4.5  | 0.074 | 1.0004 | 0.016 | 3501 | 3508 | 0.020 | 0.001 | 0.001 |
| 190 | EPR | Ethyl Propionate                                       | 1 | 0.89 | 3.5   | 1.6  | 0.083 | 1.0700 | 0.020 | 3745 | 3986 | 0.025 | 0.001 | 0.001 |
| 191 | ETE | Ethyl Toulene                                          | 1 | 0.88 | 0.28  | 4.15 | 0.078 | 1.0056 | 0.017 | 3520 | 3616 | 0.021 | 0.001 | 0.001 |
| 194 | FAM | Formamide                                              | 1 | 1.13 | 0.1   | 1.55 | 0.074 | 1.0020 | 0.016 | 3507 | 3512 | 0.020 | 0.001 | 0.001 |
| 195 | FAL | Furfuryl Alcohol                                       | 1 | 1.13 | 0.05  | 3.4  | 0.074 | 1.0010 | 0.016 | 3504 | 3516 | 0.020 | 0.001 | 0.001 |
| 197 | GAK | Gasoline Blended Stocks: Alkylates                     | 1 | 0.75 | 12.5  | 3.4  | 0.214 | 1.2500 | 0.071 | 4375 | 7462 | 0.088 | 0.004 | 0.005 |
| 198 | GRF | Gasoline Blended Stocks: Reformate                     | 1 | 0.8  | 12.5  | 3.4  | 0.214 | 1.2500 | 0.071 | 4375 | 7462 | 0.088 | 0.004 | 0.005 |
| 199 | GAT | Gasolines: Automotive (containing not over 4.23 gr 1   | 1 | 0.74 | 12.5  | 3.4  | 0.214 | 1.2500 | 0.071 | 4375 | 7462 | 0.088 | 0.004 | 0.005 |
| 200 | GAV | Gasolines: Aviation (containing not over 4.86 grams 1  | 1 | 0.71 | 12.5  | 3.4  | 0.214 | 1.2500 | 0.071 | 4375 | 7462 | 0.088 | 0.004 | 0.005 |
| 201 | GCS | Gasolines: Casinghead                                  | 1 | 0.67 | 12.5  | 3.4  | 0.214 | 1.2500 | 0.071 | 4375 | 7462 | 0.088 | 0.004 | 0.005 |
| 202 | GPL | Gasolines: Polymer                                     | 1 | 0.75 | 12.5  | 3.4  | 0.214 | 1.2500 | 0.071 | 4375 | 7462 | 0.088 | 0.004 | 0.005 |
| 203 | GSR | Gasolines: Straight Run                                | 1 | 0.75 | 12.5  | 3.4  | 0.214 | 1.2500 | 0.071 | 4375 | 7462 | 0.088 | 0.004 | 0.005 |
| 204 | GCR | Glycerine                                              | 1 | 1.26 | 0     | 3.17 | 0.074 | 1.0000 | 0.016 | 3500 | 3499 | 0.019 | 0.001 | 0.001 |
| 217 | HMX | Heptane (all isomers) (Methylhexane)                   | 1 | 0.68 | 2.5   | 3.45 | 0.102 | 1.0500 | 0.024 | 3675 | 4332 | 0.030 | 0.001 | 0.002 |
| 218 | HPT | Heptane (n-)                                           | 1 | 0.68 | 2.5   | 3.45 | 0.102 | 1.0500 | 0.024 | 3675 | 4332 | 0.030 | 0.001 | 0.002 |
| 220 | HTX | Heptanol (all isomers)                                 | 1 | 0.82 | 0.04  | 4    | 0.074 | 1.0008 | 0.016 | 3503 | 3515 | 0.020 | 0.001 | 0.001 |
| 221 | HTN | Heptanol (all isomers)                                 | 1 | 0.82 | 0.04  | 4    | 0.074 | 1.0008 | 0.016 | 3503 | 3515 | 0.020 | 0.001 | 0.001 |
| 222 | HPX | Heptene (all isomers)                                  | 2 | 0.7  | 2.9   | 3.4  | 0.106 | 1.0580 | 0.025 | 3703 | 4447 | 0.031 | 0.001 | 0.002 |
| 223 | THE | Heptene (1-)                                           | 1 | 0.7  | 2.8   | 3.4  | 0.105 | 1.0560 | 0.025 | 3696 | 4415 | 0.031 | 0.001 | 0.002 |
| 229 | HXS | Hexane (all isomers)                                   | 1 | 0.66 | 7     | 3    | 0.139 | 1.1400 | 0.038 | 3990 | 5486 | 0.048 | 0.002 | 0.002 |
| 230 | HXA | Hexane                                                 | 1 | 0.66 | 7     | 3    | 0.139 | 1.1400 | 0.038 | 3990 | 5486 | 0.048 | 0.002 | 0.002 |
| 231 | HXO | Hexanoic Acid                                          | 1 | 0.93 | 0.01  | 4    | 0.074 | 1.0002 | 0.016 | 3501 | 3503 | 0.019 | 0.001 | 0.001 |
| 232 | HXN | Hexanol                                                | 1 | 0.82 | 1     | 3.52 | 0.085 | 1.0200 | 0.019 | 3570 | 3845 | 0.023 | 0.001 | 0.001 |
| 234 | HEX | Hexene (all isomers)                                   | 2 | 0.67 | 8     | 2.9  | 0.145 | 1.1600 | 0.041 | 4060 | 5694 | 0.051 | 0.002 | 0.003 |
| 235 | HXE | Hexene (1-)                                            | 1 | 0.67 | 8.2   | 2.9  | 0.147 | 1.1640 | 0.042 | 4074 | 5749 | 0.052 | 0.002 | 0.003 |
| 236 | HXT | Hexene (2-)                                            | 1 | 0.67 | 8.2   | 2.9  | 0.147 | 1.1640 | 0.042 | 4074 | 5749 | 0.052 | 0.002 | 0.003 |
| 238 | HXG | Hexylene Glycol                                        | 4 | 0.92 | 0.01  | 1.1  | 0.074 | 1.0002 | 0.016 | 3501 | 3500 | 0.019 | 0.001 | 0.001 |
| 243 | IPH | Isophorone                                             | 1 | 0.93 | 0.01  | 4.75 | 0.074 | 1.0002 | 0.016 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 244 | JPO | Jet Fuels: JP-1 (Kerosene)                             | 1 | 0.8  | 0.14  | 4.5  | 0.076 | 1.0028 | 0.016 | 3510 | 3563 | 0.020 | 0.001 | 0.001 |
| 245 | JPT | Jet Fuels: JP-3                                        | 1 | 0.8  | 8.51  | 4.5  | 0.213 | 1.1702 | 0.062 | 4096 | 6969 | 0.077 | 0.003 | 0.004 |
| 246 | JPF | Jet Fuels: JP-4                                        | 1 | 0.81 | 3.4   | 4    | 0.121 | 1.0680 | 0.029 | 3738 | 4800 | 0.037 | 0.002 | 0.002 |
| 247 | JPV | Jet Fuels: JP-5 (Kerosene, heavy)                      | 1 | 0.82 | 0.1   | 4    | 0.075 | 1.0020 | 0.016 | 3507 | 3539 | 0.020 | 0.001 | 0.001 |
| 249 | KRS | Kerosene                                               | 1 | 0.81 | 0.15  | 4.5  | 0.076 | 1.0030 | 0.016 | 3511 | 3568 | 0.020 | 0.001 | 0.001 |
| 263 | MTT | Methyl Acetate                                         | 1 | 0.92 | 6.1   | 2.6  | 0.119 | 1.1220 | 0.032 | 3927 | 4999 | 0.040 | 0.002 | 0.002 |
| 265 | MAL | Methyl Alcohol (See Methanol)                          | 1 | 0.79 | 6.63  | 1.1  | 0.077 | 1.1326 | 0.021 | 3964 | 4046 | 0.026 | 0.001 | 0.001 |
| 266 | MAC | Methyl Amyl Acetate                                    | 1 | 0.86 | 0.33  | 4.97 | 0.080 | 1.0066 | 0.017 | 3523 | 3666 | 0.021 | 0.001 | 0.001 |
| 267 | MAA | Methyl Amyl Alcohol                                    | 1 | 0.81 | 0.43  | 3.52 | 0.079 | 1.0086 | 0.017 | 3530 | 3649 | 0.021 | 0.001 | 0.001 |
| 271 | MBK | Methyl n-Butyl Ketone                                  | 1 | 0.81 | 0.97  | 3.5  | 0.085 | 1.0194 | 0.019 | 3568 | 3832 | 0.023 | 0.001 | 0.001 |
| 273 | MBU | Methyl Butyrate                                        | 1 | 0.9  | 1.26  | 3.53 | 0.089 | 1.0252 | 0.020 | 3588 | 3935 | 0.025 | 0.001 | 0.001 |
| 274 | MEK | Methyl Ethyl Ketone                                    | 1 | 0.8  | 4.5   | 2.5  | 0.105 | 1.0900 | 0.027 | 3815 | 4561 | 0.033 | 0.001 | 0.002 |
| 275 | MTF | Methyl Formal (Dimethyl Formal)                        | 1 | 0.86 | 15.42 | 2.6  | 0.189 | 1.3084 | 0.069 | 4579 | 7341 | 0.085 | 0.004 | 0.004 |
| 276 | MHK | Methyl Heptyl Ketone                                   | 1 | 0.83 | 0.06  | 4.9  | 0.075 | 1.0012 | 0.016 | 3504 | 3529 | 0.020 | 0.001 | 0.001 |
| 278 | MIK | Methyl Isobutyl Ketone                                 | 1 | 0.8  | 1.15  | 3.45 | 0.087 | 1.0230 | 0.019 | 3581 | 3887 | 0.024 | 0.001 | 0.001 |
| 281 | MNA | 1-Methyl Naphthalene                                   | 1 | 1.02 | 0.01  | 4.91 | 0.074 | 1.0002 | 0.016 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 283 | MPN | 2-Methyl-1-Pentene                                     | 1 | 0.69 | 6.3   | 2.9  | 0.130 | 1.1260 | 0.035 | 3941 | 5230 | 0.043 | 0.002 | 0.002 |
| 284 | MTN | 5-Methyl-1-Pentene                                     | 1 | 0.67 | 8.49  | 2.9  | 0.149 | 1.1698 | 0.043 | 4094 | 5828 | 0.054 | 0.002 | 0.003 |
| 286 | MBE | Methyl Tert-Butyl Ether (MTBE)                         | 1 | 0.74 | 0.04  | 3.1  | 0.074 | 1.0008 | 0.016 | 3503 | 3511 | 0.020 | 0.001 | 0.001 |
| 288 | MNS | Mineral Spirits                                        | 1 | 0.75 | 0.2   | 4.3  | 0.077 | 1.0040 | 0.016 | 3514 | 3586 | 0.020 | 0.001 | 0.001 |
| 289 | MRE | Myrcene                                                | 1 | 0.8  | 0.17  | 4.7  | 0.077 | 1.0034 | 0.016 | 3512 | 3581 | 0.020 | 0.001 | 0.001 |
| 295 | NSV | Naphtha: Solvent                                       | 1 | 0.87 | 0.2   | 3.5  | 0.076 | 1.0040 | 0.016 | 3514 | 3569 | 0.020 | 0.001 | 0.001 |
| 296 | NSS | Naphtha: Stoddard Solvant                              | 1 | 0.78 | 0.2   | 4.3  | 0.077 | 1.0040 | 0.016 | 3514 | 3586 | 0.020 | 0.001 | 0.001 |
| 297 | NVM | Naphtha: Varnish Maker's and Painters (75%)            | 1 | 0.77 | 0.19  | 4.3  | 0.077 | 1.0038 | 0.016 | 3513 | 3582 | 0.020 | 0.001 | 0.001 |
| 300 | NAX | Nonane (all isomers)                                   | 1 | 0.72 | 0.27  | 4.4  | 0.078 | 1.0054 | 0.017 | 3519 | 3619 | 0.021 | 0.001 | 0.001 |
| 301 | NAN | Nonane                                                 | 1 | 0.72 | 0.27  | 4.4  | 0.078 | 1.0054 | 0.017 | 3519 | 3619 | 0.021 | 0.001 | 0.001 |
| 304 | NON | Nonene                                                 | 1 | 0.73 | 0.35  | 4.3  | 0.079 | 1.0070 | 0.017 | 3525 | 3651 | 0.021 | 0.001 | 0.001 |
| 305 | NNS | Nonyl Alcohol (all isomers)                            | 1 | 0.94 | 0.1   | 5    | 0.076 | 1.0020 | 0.016 | 3507 | 3550 | 0.020 | 0.001 | 0.001 |
| 306 | NNN | Nonyl Alcohol                                          | 1 | 0.94 | 0.1   | 5    | 0.076 | 1.0020 | 0.016 | 3507 | 3550 | 0.020 | 0.001 | 0.001 |
| 307 | NNI | Nonyl Alcohol (iso-)                                   | 1 | 0.94 | 0.1   | 5    | 0.076 | 1.0020 | 0.016 | 3507 | 3550 | 0.020 | 0.001 | 0.001 |
| 309 | NNP | Nonyl Phenol                                           | 1 | 0.95 | 0.01  | 7.6  | 0.074 | 1.0002 | 0.016 | 3501 | 3507 | 0.019 | 0.001 | 0.001 |
| 316 | OAX | Octane (all isomers)                                   | 1 | 0.7  | 0.79  | 3.9  | 0.084 | 1.0158 | 0.019 | 3555 | 3805 | 0.023 | 0.001 | 0.001 |
| 317 | OAN | Octane                                                 | 1 | 0.7  | 0.79  | 3.9  | 0.084 | 1.0158 | 0.019 | 3555 | 3805 | 0.023 | 0.001 | 0.001 |
| 320 | OTA | Octanol                                                | 1 | 0.83 | 0.01  | 4.48 | 0.074 | 1.0002 | 0.016 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 322 | OTE | Octene (1-)                                            | 1 | 0.72 | 1     | 3.86 | 0.087 | 1.0200 | 0.019 | 3570 | 3880 | 0.024 | 0.001 | 0.001 |
| 324 | OCX | Octyl Alcohol (iso-, n-) (all isomers), See Octanol (1 | 1 | 0.83 | 0.01  | 4.48 | 0.074 | 1.0002 | 0.016 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 325 | IOA | Octyl Alcohol                                          | 1 | 0.83 | 0.01  | 4.48 | 0.074 | 1.0002 | 0.016 | 3501 | 3504 | 0.019 | 0.001 | 0.001 |
| 364 | OTW | Fuel: No. 2                                            | 1 | 0.88 | 0.56  | 8    | 0.092 | 1.0112 | 0.020 | 3539 | 3955 | 0.025 | 0.001 | 0.001 |

|         |                                                       |   |       |        |        |       |        |       |      |       |       |       |       |
|---------|-------------------------------------------------------|---|-------|--------|--------|-------|--------|-------|------|-------|-------|-------|-------|
| 366 OFR | Fuel: No. 4                                           | 1 | 0.9   | 0.15   | 3.4    | 0.075 | 1.0030 | 0.016 | 3511 | 3550  | 0.020 | 0.001 | 0.001 |
| 367 OFV | Fuel: No. 5                                           | 1 | 0.94  | 0.15   | 3.4    | 0.075 | 1.0030 | 0.016 | 3511 | 3550  | 0.020 | 0.001 | 0.001 |
| 368 OSX | Fuel: No. 6                                           | 1 | 0.95  | 0.15   | 3.4    | 0.075 | 1.0030 | 0.016 | 3511 | 3550  | 0.020 | 0.001 | 0.001 |
| 382 OIL | OIL, Misc: Crude                                      | 1 | 0.95  | 0.15   | 3.4    | 0.075 | 1.0030 | 0.016 | 3511 | 3550  | 0.020 | 0.001 | 0.001 |
| 383 ODS | OIL, Misc: Diesel                                     | 1 | 0.9   | 0.69   | 3.4    | 0.081 | 1.0138 | 0.018 | 3548 | 3730  | 0.022 | 0.001 | 0.001 |
| 389 OLB | OIL, Misc: Lubricating                                | 1 | 0.9   | 0.15   | 1      | 0.074 | 1.0030 | 0.016 | 3511 | 3510  | 0.020 | 0.001 | 0.001 |
| 403 ORS | OIL, Misc: Resin                                      | 1 | 1.02  | 0.15   | 1      | 0.074 | 1.0030 | 0.016 | 3511 | 3510  | 0.020 | 0.001 | 0.001 |
| 418 OTB | OIL, Misc: Turbine                                    | 1 | 0.87  | 0.3    | 5.4    | 0.080 | 1.0060 | 0.017 | 3521 | 3685  | 0.021 | 0.001 | 0.001 |
| 429 PDC | Pentadecanol, See Alcohols (C13 and above)            | 1 | 0.83  | 0.01   | 7.88   | 0.074 | 1.0002 | 0.016 | 3501 | 3507  | 0.019 | 0.001 | 0.001 |
| 433 IPT | Pentane (iso-)                                        | 5 | 0.62  | 27     | 2.48   | 0.335 | 1.5400 | 0.169 | 5390 | 11501 | 0.210 | 0.009 | 0.011 |
| 434 PTA | Pentane (n-)                                          | 5 | 0.63  | 20.44  | 2.5    | 0.256 | 1.4088 | 0.108 | 4931 | 9191  | 0.134 | 0.006 | 0.007 |
| 437 PTE | Pentene (1-)                                          | 5 | 0.64  | 24.9   | 2.4    | 0.299 | 1.4980 | 0.143 | 5243 | 10568 | 0.177 | 0.007 | 0.009 |
| 442 PIN | Pinene                                                | 1 | 0.86  | 0.35   | 4.7    | 0.080 | 1.0070 | 0.017 | 3525 | 3666  | 0.021 | 0.001 | 0.001 |
| 448 PLB | Polybutene                                            | 1 | 0.91  | 0.01   | 79.3   | 0.077 | 1.0002 | 0.016 | 3501 | 3586  | 0.020 | 0.001 | 0.001 |
| 457 PGC | Polypropylene Glycol                                  | 1 | 1.01  | 0.1    | 1      | 0.074 | 1.0020 | 0.016 | 3507 | 3506  | 0.019 | 0.001 | 0.001 |
| 464 IAC | Propyl Acetate (iso-)                                 | 1 | 0.89  | 1.8    | 3.52   | 0.095 | 1.0360 | 0.022 | 3626 | 4115  | 0.027 | 0.001 | 0.001 |
| 465 PAT | Propyl Acetate (n-)                                   | 1 | 0     | 1.85   | 3.52   | 0.095 | 1.0370 | 0.022 | 3630 | 4132  | 0.027 | 0.001 | 0.001 |
| 466 IPA | Propyl Alcohol (iso-)                                 | 1 | 0.79  | 3      | 2.07   | 0.089 | 1.0600 | 0.021 | 3710 | 4071  | 0.026 | 0.001 | 0.001 |
| 467 PAL | Propyl Alcohol (n-)                                   | 1 | 0.8   | 1.2    | 2.07   | 0.080 | 1.0240 | 0.018 | 3584 | 3727  | 0.022 | 0.001 | 0.001 |
| 468 PBZ | Propylbenzene (n-)                                    | 1 | 0.86  | 0.2    | 4.14   | 0.077 | 1.0040 | 0.016 | 3514 | 3583  | 0.020 | 0.001 | 0.001 |
| 469 IPX | Iso-Propylcyclohexane                                 | 1 | 0.8   | 0.01   | 4.35   | 0.074 | 1.0002 | 0.016 | 3501 | 3503  | 0.019 | 0.001 | 0.001 |
| 473 PPG | Propylene Glycol (1,2-Propandiol)                     | 1 | 1.04  | 0.01   | 2.62   | 0.074 | 1.0002 | 0.016 | 3501 | 3502  | 0.019 | 0.001 | 0.001 |
| 476 PME | Propylene Glycol Methyl Ether                         | 1 | 0.92  | 0.7    | 3.11   | 0.081 | 1.0140 | 0.018 | 3549 | 3711  | 0.022 | 0.001 | 0.001 |
| 488 SFL | Sulfolane                                             | 1 | 1.26  | 0.01   | 4.14   | 0.074 | 1.0002 | 0.016 | 3501 | 3503  | 0.019 | 0.001 | 0.001 |
| 493 TTN | Tetradecanol                                          | 1 | 0.82  | 0      | 7.39   | 0.074 | 1.0000 | 0.016 | 3500 | 3499  | 0.019 | 0.001 | 0.001 |
| 494 TTD | 1-Tetradecene, See the olefin or Alpha-Olefin Entries | 1 | 0.77  | 0.01   | 6.77   | 0.074 | 1.0002 | 0.016 | 3501 | 3506  | 0.019 | 0.001 | 0.001 |
| 496 TTG | Tetraethylene Glycol                                  | 1 | 1.12  | 0.01   | 6.7    | 0.074 | 1.0002 | 0.016 | 3501 | 3506  | 0.019 | 0.001 | 0.001 |
| 497 THN | Tetrahydronaphthalene                                 | 1 | 0.97  | 0.04   | 4.56   | 0.074 | 1.0008 | 0.016 | 3503 | 3518  | 0.020 | 0.001 | 0.001 |
| 499 TOL | Toluene                                               | 1 | 0.87  | 1.5    | 3.14   | 0.089 | 1.0300 | 0.020 | 3605 | 3955  | 0.025 | 0.001 | 0.001 |
| 502 TCP | Tricresyl Phosphate (less than 1% of the ortho isom)  | 1 | 1.16  | 0.01   | 12.69  | 0.074 | 1.0002 | 0.016 | 3501 | 3513  | 0.020 | 0.001 | 0.001 |
| 503 TRD | Tridecane                                             | 1 | 0.76  | 0.02   | 6.4    | 0.074 | 1.0004 | 0.016 | 3501 | 3512  | 0.020 | 0.001 | 0.001 |
| 505 TDN | Tridecanol, See Alcohols (C13 and above)              | 1 | 0.85  | 0.01   | 6.91   | 0.074 | 1.0002 | 0.016 | 3501 | 3506  | 0.019 | 0.001 | 0.001 |
| 506 TDC | 1-Tridecene                                           | 1 | 0.77  | 0.01   | 6.29   | 0.074 | 1.0002 | 0.016 | 3501 | 3506  | 0.019 | 0.001 | 0.001 |
| 508 TEB | Triethylbenzene                                       | 1 | 0.86  | 0.02   | 5.6    | 0.074 | 1.0004 | 0.016 | 3501 | 3511  | 0.020 | 0.001 | 0.001 |
| 509 TEG | Triethylene Glycol                                    | 1 | 1.12  | 0.01   | 5.17   | 0.074 | 1.0002 | 0.016 | 3501 | 3504  | 0.019 | 0.001 | 0.001 |
| 519 TRE | Trimethylbenzenes (all isomers)                       | 1 | 0.89  | 0.14   | 4.2    | 0.076 | 1.0028 | 0.016 | 3510 | 3559  | 0.020 | 0.001 | 0.001 |
| 520 TMB | Trimethyl Benzene (1,2,5-)                            | 1 | 0.89  | 0.14   | 4.14   | 0.076 | 1.0028 | 0.016 | 3510 | 3558  | 0.020 | 0.001 | 0.001 |
| 521 TMD | Trimethyl Benzene (1,2,3-)                            | 1 | 0.89  | 0.14   | 4.14   | 0.076 | 1.0028 | 0.016 | 3510 | 3558  | 0.020 | 0.001 | 0.001 |
| 522 TME | Trimethyl Benzene (1,2,4-) (Pseudocumene)             | 1 | 0.89  | 0.14   | 4.14   | 0.076 | 1.0028 | 0.016 | 3510 | 3558  | 0.020 | 0.001 | 0.001 |
| 529 TRP | Triphenyl Phosphate                                   | 1 | 1.16  | 0      | 14.2   | 0.074 | 1.0000 | 0.016 | 3500 | 3499  | 0.019 | 0.001 | 0.001 |
| 546 XLX | Xylenes (Ortho-, meta-, para-)                        | 1 | 0.89  | 0.51   | 3.66   | 0.080 | 1.0102 | 0.017 | 3536 | 3684  | 0.022 | 0.001 | 0.001 |
| 547 XLM | Xylene (M-)                                           | 1 | 0.87  | 0.51   | 3.66   | 0.080 | 1.0102 | 0.017 | 3536 | 3684  | 0.022 | 0.001 | 0.001 |
| 548 XLO | Xylene (O-)                                           | 1 | 0.89  | 0.4    | 3.66   | 0.079 | 1.0080 | 0.017 | 3528 | 3645  | 0.021 | 0.001 | 0.001 |
| 549 XLP | Xylene (P-)                                           | 1 | 0.86  | 0.51   | 3.66   | 0.080 | 1.0102 | 0.017 | 3536 | 3684  | 0.022 | 0.001 | 0.001 |
| 550 XYL | Xylenol                                               | 1 | 1.01  | 0.1    | 3.66   | 0.075 | 1.0020 | 0.016 | 3507 | 3536  | 0.020 | 0.001 | 0.001 |
| 551     | Zinc Dialkyldithiophosphate                           |   |       |        |        |       |        |       |      |       |       |       |       |
|         | Max.                                                  |   | 1.260 | 27.000 | 79.300 | 0.335 | 1.540  | 0.169 | 5390 | 11501 | 0.210 | 0.009 | 0.011 |
|         | Min.                                                  |   | 0.000 | 0.000  | 1.000  | 0.000 | 1.000  | 0.016 | 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)

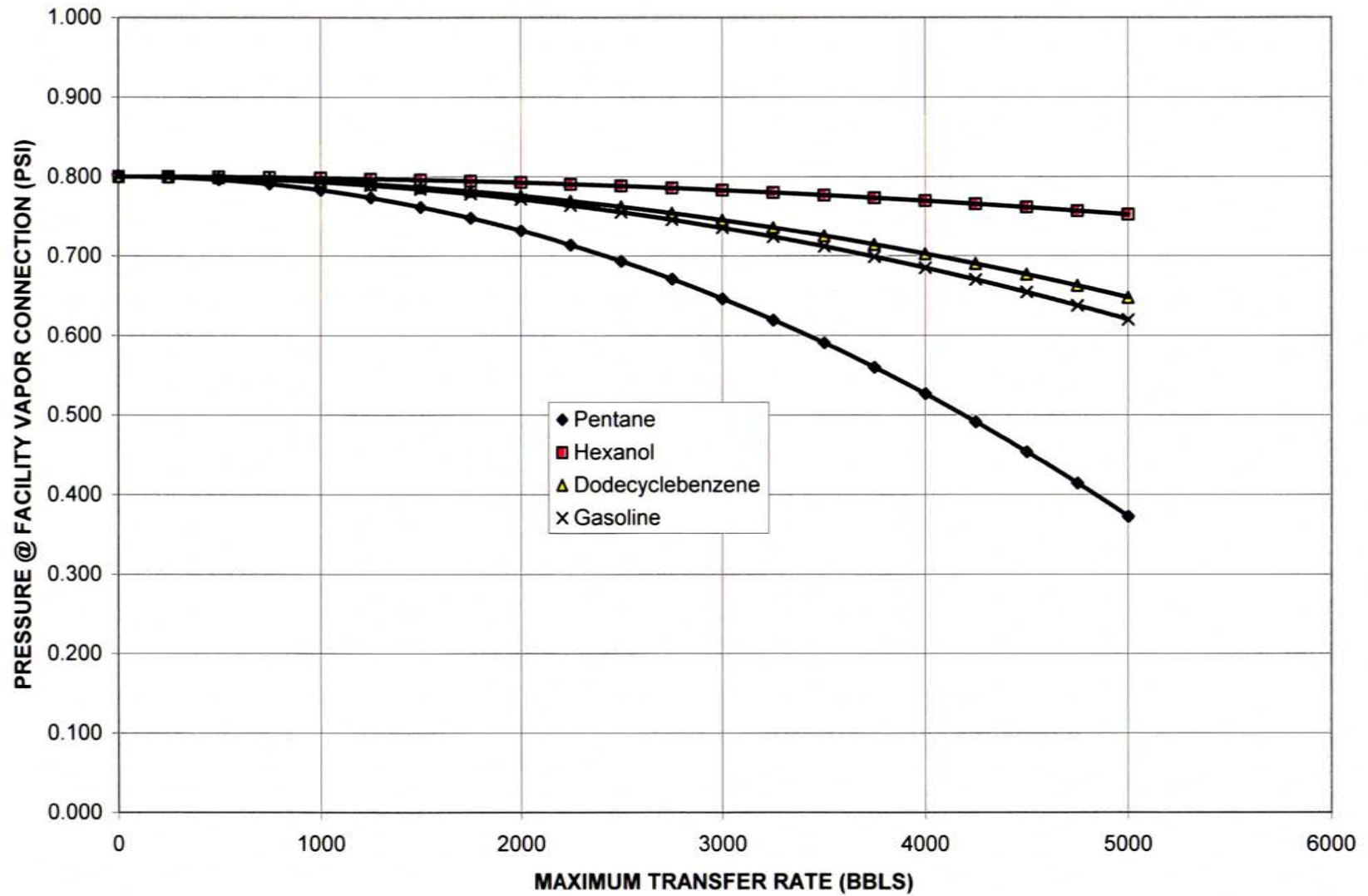
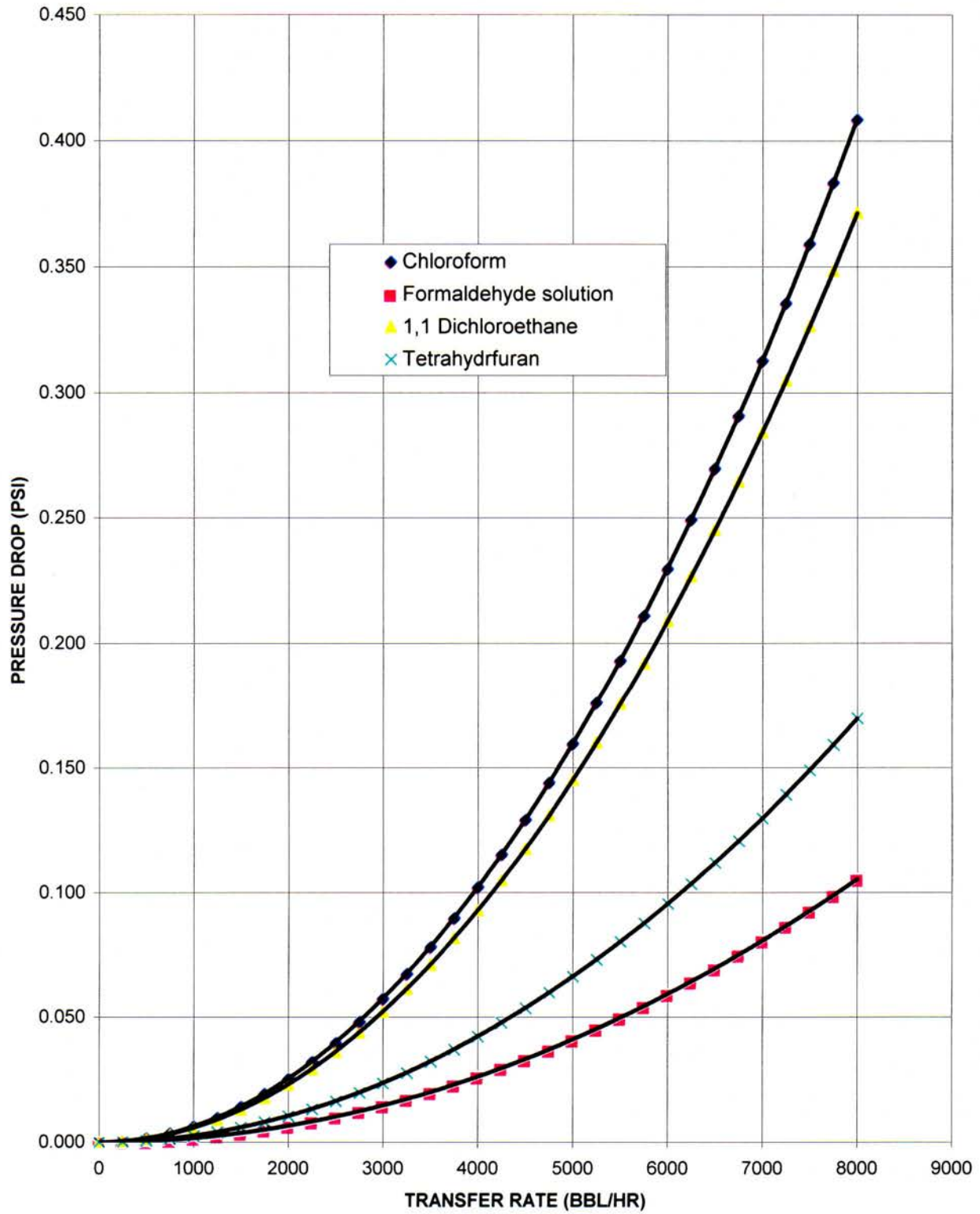


TABLE 4 (SUBCHAPTER "O" CARGOES)

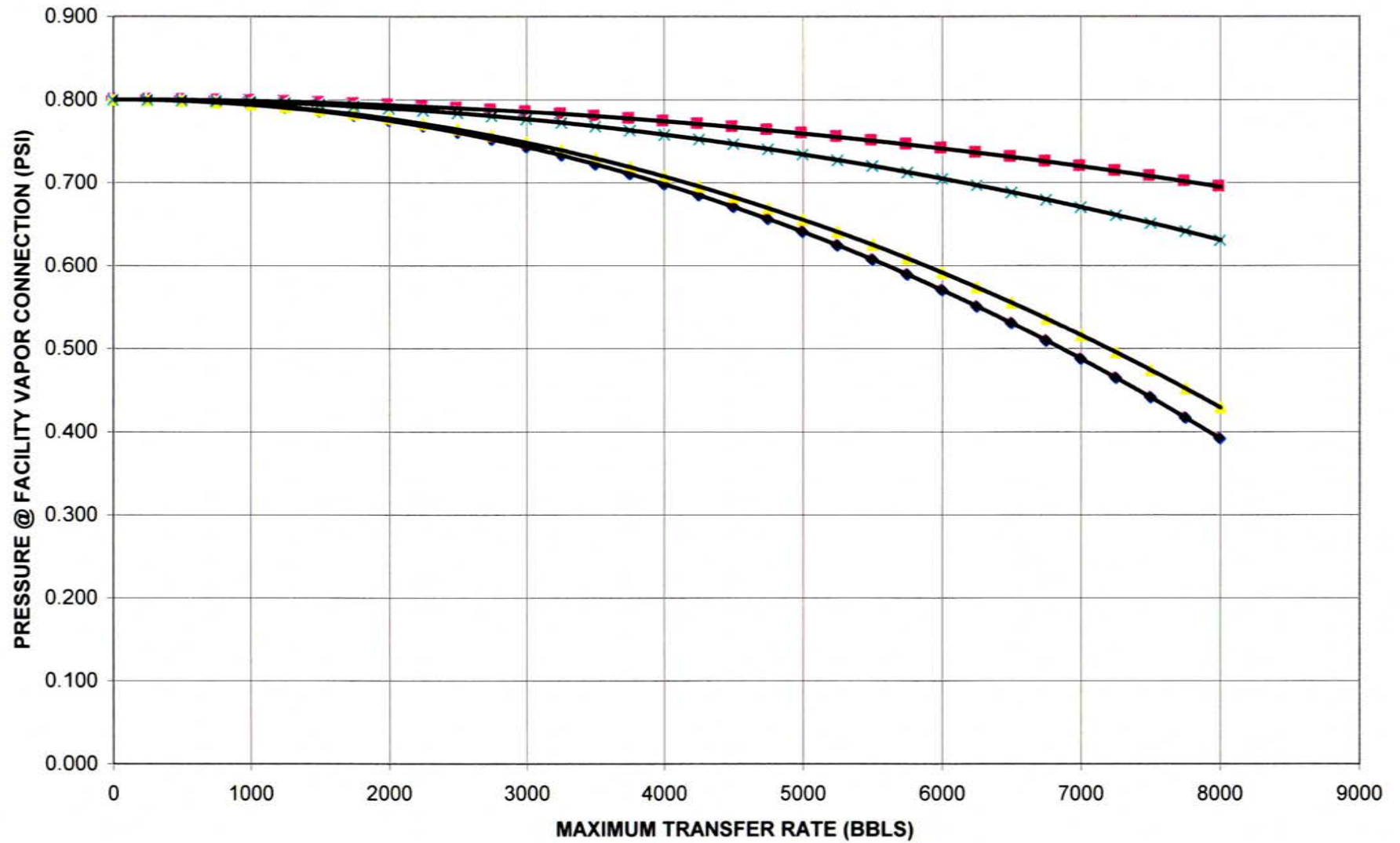
| CHRIS<br>CODE | NAME                                                    | VCS<br>CAT | LIQ<br>SG | VAPOR<br>PRESS | VAPOR<br>SG | VAPOR<br>AIR<br>WEIGHT<br>DENSITY | VAPOR<br>GROWTH<br>RATE | PRESSURE<br>DROP TO PV<br>VALVE IN<br>VCS(psig)<br>(LOADING) | VAPOR<br>VOLUMETRIC<br>FLOW RATE<br>(bbl/h) | 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                  | 0.024                                                        | 3850                                        | 4298                                         | 0.030                                                                     | 0.001                                                          | 0.002                                                                       |
| 2 ADN         | Adiponitrile                                            | 1          | 0.95      | 0.01           | 3.73        | 0.076                             | 1.0002                  | 0.016                                                        | 3501                                        | 3503                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 3 ATN         | Acetonitrile                                            | 3          | 0.78      | 0.03           | 1.41        | 0.076                             | 1.0006                  | 0.016                                                        | 3502                                        | 3502                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 4 BAD         | Iso-Butyraldehyde                                       | 1          | 0.80      | 7.80           | 2.50        | 0.131                             | 1.1560                  | 0.037                                                        | 4046                                        | 5308                                         | 0.046                                                                     | 0.002                                                          | 0.002                                                                       |
| 5 BAR         | Butyl acrylate (iso-, n-)                               | 2          | 0.90      | 0.60           | 4.42        | 0.086                             | 1.0120                  | 0.019                                                        | 3542                                        | 3759                                         | 0.023                                                                     | 0.001                                                          | 0.001                                                                       |
| 6 BMH         | Butyl Methacrylate                                      | 2          | 0.88      | 0.29           | 4.9         | 0.081                             | 1.0058                  | 0.017                                                        | 3520                                        | 3640                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 7 BNZ         | Benzene                                                 | 1          | 0.88      | 4.50           | 2.80        | 0.114                             | 1.0900                  | 0.029                                                        | 3815                                        | 4671                                         | 0.036                                                                     | 0.002                                                          | 0.002                                                                       |
| 8 BTR         | n-Butyraldehyde                                         | 1          | 0.80      | 7.80           | 2.50        | 0.131                             | 1.1560                  | 0.037                                                        | 4046                                        | 5308                                         | 0.046                                                                     | 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                  | 0.038                                                        | 4011                                        | 5396                                         | 0.048                                                                     | 0.002                                                          | 0.002                                                                       |
| 10 CCH        | Cyclohexanone                                           | 1          | 0.95      | 0.20           | 3.40        | 0.078                             | 1.0040                  | 0.017                                                        | 3514                                        | 3565                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 11 CHA        | Cyclohexylamine                                         | 1          | 0.87      | 0.62           | 3.42        | 0.083                             | 1.0124                  | 0.018                                                        | 3543                                        | 3703                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 12 CRB        | Chlorobenzene                                           | 1          | 1.11      | 0.80           | 3.88        | 0.087                             | 1.0160                  | 0.019                                                        | 3556                                        | 3799                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 13 CRF        | Chloroform                                              | 3          | 1.48      | 9              | 4.25        | 0.213                             | 1.1800                  | 0.063                                                        | 4130                                        | 6916                                         | 0.078                                                                     | 0.003                                                          | 0.004                                                                       |
| 14 NCT        | Coal Tar Naphtha Solvent                                | 1          | 0.86      | 0.2            | 4           | 0.079                             | 1.0040                  | 0.017                                                        | 3514                                        | 3577                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 15 CRS        | Cresols                                                 | 1          | 1.05      | 0.06           | 3.72        | 0.077                             | 1.0012                  | 0.016                                                        | 3504                                        | 3521                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 16 CTA        | Crotonaldehyde                                          | 4          | 0.85      | 2              | 2.41        | 0.089                             | 1.0400                  | 0.021                                                        | 3640                                        | 3943                                         | 0.025                                                                     | 0.001                                                          | 0.001                                                                       |
| 17 DCH        | 1,1-Dichloroethane                                      | 1          | 1.18      | 9.90           | 3.41        | 0.188                             | 1.1980                  | 0.057                                                        | 4193                                        | 6592                                         | 0.071                                                                     | 0.003                                                          | 0.004                                                                       |
| 18 DPP        | 1,2-Dichloropropane                                     | 3          | 1.16      | 2.5            | 3.89        | 0.110                             | 1.0500                  | 0.026                                                        | 3675                                        | 4418                                         | 0.032                                                                     | 0.001                                                          | 0.002                                                                       |
| 19 DPU        | 1,3-Dichloropropene                                     | 4          | 1.23      | 5.5            | 3.84        | 0.149                             | 1.1100                  | 0.039                                                        | 3885                                        | 5443                                         | 0.048                                                                     | 0.002                                                          | 0.003                                                                       |
| 20 DEN        | Diethylamine                                            | 3          | 0.71      | 1.00           | 2.50        | 0.083                             | 1.0200                  | 0.018                                                        | 3570                                        | 3731                                         | 0.023                                                                     | 0.001                                                          | 0.001                                                                       |
| 21 DIP        | Diisopropanolamine                                      | 1          | 0.98      | 0.01           | 4.59        | 0.076                             | 1.0002                  | 0.016                                                        | 3501                                        | 3504                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 22 DMF        | Dimethylformamide                                       | 1          | 0.95      | 0.30           | 2.51        | 0.078                             | 1.0060                  | 0.017                                                        | 3521                                        | 3569                                         | 0.021                                                                     | 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                  | 0.044                                                        | 3941                                        | 5747                                         | 0.054                                                                     | 0.002                                                          | 0.003                                                                       |
| 24 EAC        | Ethyl acrylate                                          | 2          | 0.93      | 2.00           | 3.50        | 0.099                             | 1.0400                  | 0.023                                                        | 3640                                        | 4163                                         | 0.028                                                                     | 0.001                                                          | 0.001                                                                       |
| 25 EAI        | 2-Ethylhexyl acrylate                                   | 2          | 0.89      | 0.02           | 6.35        | 0.076                             | 1.0004                  | 0.016                                                        | 3501                                        | 3512                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 26 EDC        | Ethylene dichloride                                     | 1          | 1.26      | 4.00           | 3.42        | 0.121                             | 1.0800                  | 0.030                                                        | 3780                                        | 4776                                         | 0.037                                                                     | 0.002                                                          | 0.002                                                                       |
| 27 ETM        | Ethyl Methacrylate                                      | 2          | 0.92      | 1              | 3.94        | 0.090                             | 1.0200                  | 0.020                                                        | 3570                                        | 3879                                         | 0.025                                                                     | 0.001                                                          | 0.001                                                                       |
| 28 EPA        | 2-Ethyl-3-propylacrolein                                | 1          | 0.85      | 0.12           | 4.5         | 0.078                             | 1.0024                  | 0.017                                                        | 3508                                        | 3553                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 29 FFA        | Furfural                                                | 1          | 1.20      | 0.15           | 3.31        | 0.078                             | 1.0030                  | 0.017                                                        | 3511                                        | 3547                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 30 FMS        | Formaldehyde solution (37% to 50%)                      | 1          | 1.13      | 0.15           | 1.03        | 0.076                             | 1.0030                  | 0.016                                                        | 3511                                        | 3510                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 31 MSO        | Mesityl Oxide                                           | 1          | 0.86      | 0.67           | 3.5         | 0.084                             | 1.0134                  | 0.018                                                        | 3547                                        | 3725                                         | 0.023                                                                     | 0.001                                                          | 0.001                                                                       |
| 32 MAM        | Methyl acrylate                                         | 2          | 0.95      | 4.10           | 3.00        | 0.114                             | 1.0820                  | 0.028                                                        | 3787                                        | 4646                                         | 0.035                                                                     | 0.001                                                          | 0.002                                                                       |
| 33 MBE        | Methylcyclopentadiene dimer                             | 1          | 0.74      | 0.04           | 3.10        | 0.076                             | 1.0008                  | 0.016                                                        | 3503                                        | 3511                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |
| 34 MMM        | Methyl methacrylate                                     | 2          | 0.94      | 2.02           | 3.45        | 0.099                             | 1.0404                  | 0.023                                                        | 3641                                        | 4159                                         | 0.028                                                                     | 0.001                                                          | 0.001                                                                       |
| 35 MPL        | Morpholine                                              | 1          | 1.00      | 0.80           | 3.00        | 0.083                             | 1.0160                  | 0.018                                                        | 3556                                        | 3726                                         | 0.023                                                                     | 0.001                                                          | 0.001                                                                       |
| 36 NPM        | 1- or 2-Nitropropane                                    | 1          | 0.99      | 1.05           | 3.06        | 0.086                             | 1.0210                  | 0.019                                                        | 3574                                        | 3804                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 37 PRD        | Pyridine                                                | 1          | 0.98      | 1.30           | 2.72        | 0.086                             | 1.0260                  | 0.019                                                        | 3591                                        | 3830                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 38 STY        | Styrene                                                 | 2          | 0.92      | 0.40           | 3.60        | 0.081                             | 1.0080                  | 0.017                                                        | 3528                                        | 3638                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 39 TCN        | 1,2,3-Trichloropropane                                  | 3          | 1.39      | 0.15           | 5.60        | 0.079                             | 1.0030                  | 0.017                                                        | 3511                                        | 3583                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 40 TEN        | Triethylamine                                           | 3          | 0.73      | 2.50           | 3.49        | 0.105                             | 1.0500                  | 0.025                                                        | 3675                                        | 4323                                         | 0.031                                                                     | 0.001                                                          | 0.002                                                                       |
| 41 THF        | Tetrahydrofuran                                         | 1          | 0.89      | 8.50           | 1.35        | 0.090                             | 1.1700                  | 0.026                                                        | 4095                                        | 4454                                         | 0.032                                                                     | 0.001                                                          | 0.002                                                                       |
| 42 VAM        | Vinyl acetate                                           | 2          | 0.94      | 5.80           | 2.97        | 0.130                             | 1.1160                  | 0.034                                                        | 3906                                        | 5099                                         | 0.043                                                                     | 0.002                                                          | 0.002                                                                       |
|               |                                                         | Max.       | 1.39      | 12.5           | 8.40        | 0.213                             | 1.198                   | 0.063                                                        | 4193                                        | 6916                                         | 0.078                                                                     | 0.003                                                          | 0.004                                                                       |
|               |                                                         | Min.       | 0.63      | 0.01           | 1.03        | 0.076                             | 1.000                   | 0.016                                                        | 3501                                        | 3502                                         | 0.020                                                                     | 0.001                                                          | 0.001                                                                       |

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

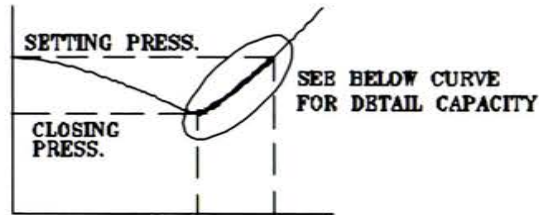
# LIQUID TRANSFER RATE vs PRESSURE DROP



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



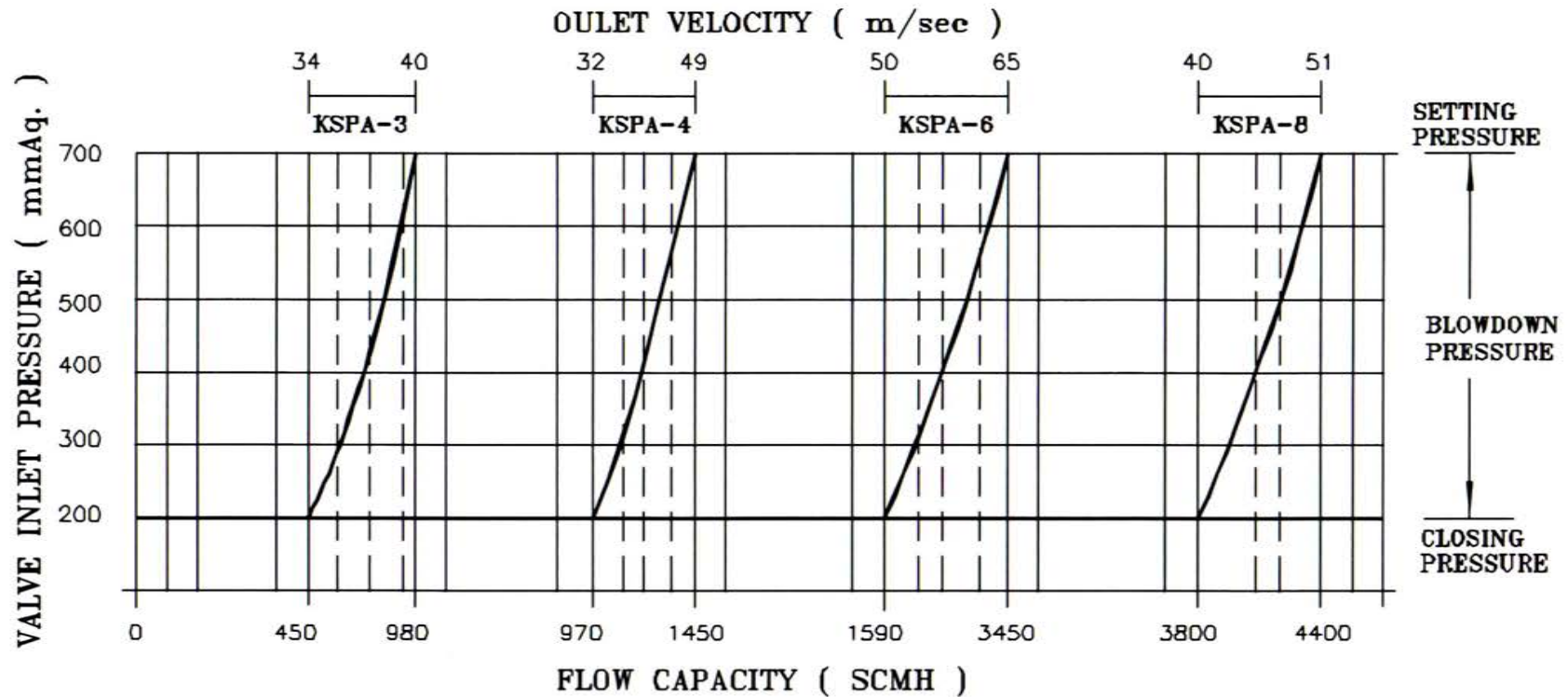
# PROGRESS OF VALVE PRESSURE



## TANKTECH HIGH VELOCITY VENT VALVES

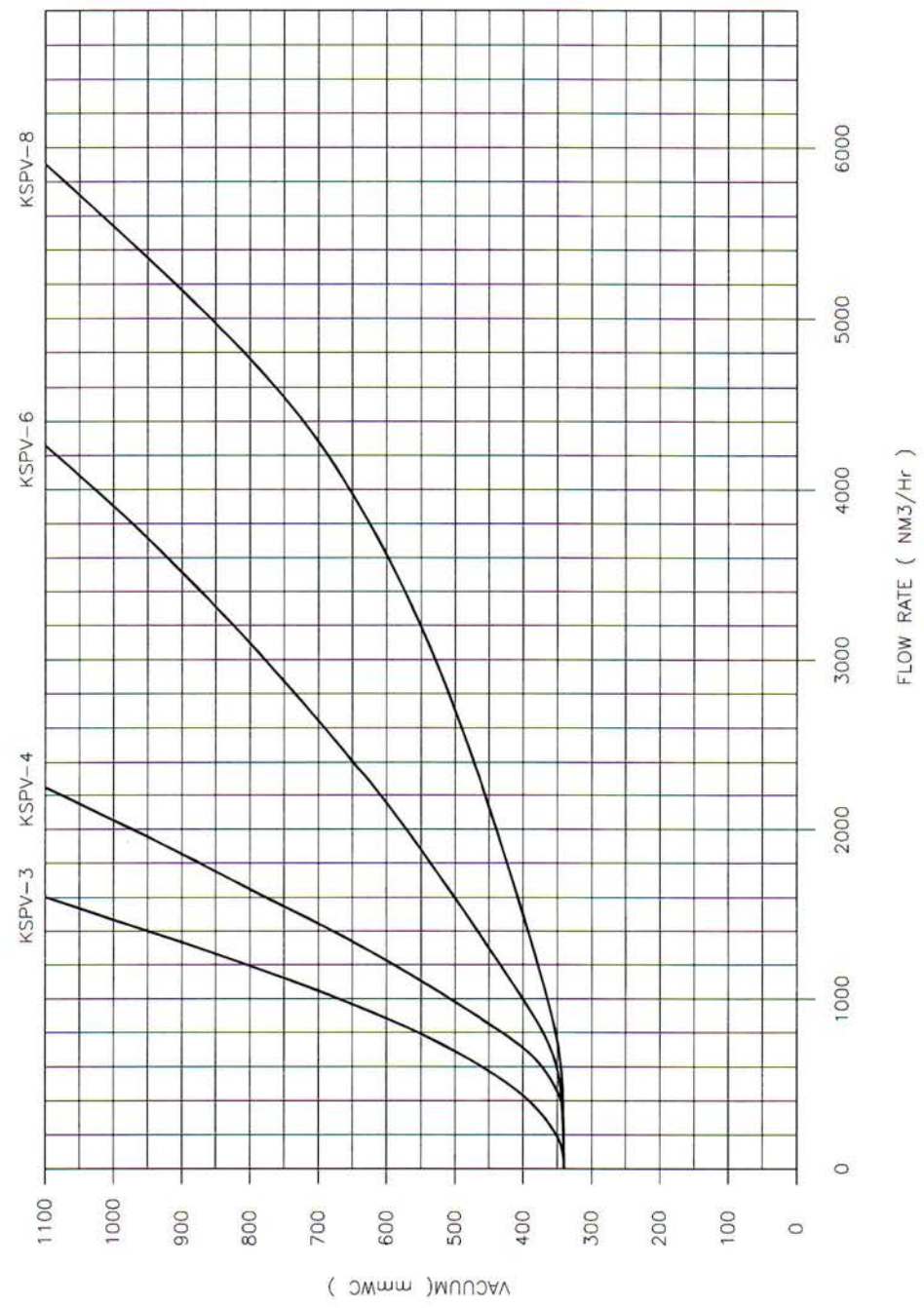
### KSPA TYPE FLOW CAPACITY CURVE

700 mmAq. SETTING PRESSURE



# FLOW CAPACITY CURVE GRAPH

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



TANKTECH

TITLE HIGH VELOCITY VACUUM RELIEF VALVE  
KSPV TYPE



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



|                 |                     |          |           |
|-----------------|---------------------|----------|-----------|
| 1. Vessel Name  | CBC 1380 - CBC 1387 | Shipyard | SOUTHWEST |
| Official Number |                     | Hull #   | 9839-9746 |

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

**3. Tank Design:**

|              |                                     |                                                                                                      |          |
|--------------|-------------------------------------|------------------------------------------------------------------------------------------------------|----------|
| Raised Trunk | <input checked="" type="checkbox"/> | Maximum Design Working Pressure:                                                                     | 3.5 psig |
| Flush Deck   | <input type="checkbox"/>            | Existing Raised Trunk Barges need MSC approval letter serial number and date which approved its MDWP |          |

**4. Requested Maximum Cargo Transfer Rates**

|     |                    |
|-----|--------------------|
| 350 | bbl/hr loading     |
| 800 | bbl/hr discharging |

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

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

|               |         |       |         |
|---------------|---------|-------|---------|
| a. Cargo Name | PENTANE | 0.335 | lbm/ft3 |
| b. Cargo Name | PENTANE | 0.335 | lbm/ft3 |

**6. VCS Categories Requested (list):** 1-5

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

|                                                         | Cargo A<br>psi | Cargo B<br>psi |
|---------------------------------------------------------|----------------|----------------|
| a. Most Remote Cargo Tank to P/V valve                  | 0.169          | 0.169          |
| b. Most Remote Cargo Tank to VCS Facility Connection    | 0.210          | 0.210          |
| c. ΔP across P/V valve @ cargoes' Maximum Transfer Rate | 1.0            | 1.0            |
| d. ΔP across Vacuum P/V @ MTR or Max. Discharge Rate    | 0.5            |                |
| e. ΔP across Spill Valve for Max. Density Cargo at MTR  | -              |                |

**8. Pressure Vacuum Valve:**

|                    |                   |
|--------------------|-------------------|
| Manufacturer       | Settings in psig: |
| Model/Size         | Pressure-side     |
| CG Approval Number | Vacuum-side       |

BERGAN      1.00  
KLPH-6      0.50  
162.017/144/13

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

**9. VCS Pipe Sizes:**

Longitudinal Header 7.981 inches      Transverse Headers 7.981 inches

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

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

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

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

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

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

**14. Previous VCS approval letters:**

|  |  |  |
|--|--|--|
|  |  |  |
|  |  |  |