

**VAPOR COLLECTION SYSTEM CALCULATIONS**

**FOR**

**BARGE NAME(s): "CBC 1700" thru "CBC 1709"**

**SOUTHWEST SHIPYARD HULL(s): 9803 thru 9812  
(MSC PROJECT No. P021996)**

**200'-0" X 54'-0" X 12'-0" DOUBLE SKIN TANK BARGE (O/D)**

**CANAL BARGE COMPANY, INC.**

**January 16, 2019**

**Prepared by:**

A handwritten signature in black ink, appearing to read 'Kumaria', with a long horizontal stroke extending to the left.

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# MARINE SOLUTIONS, INC.

## VCS SYSTEM INFORMATION:

### 1. GENERAL DESCRIPTION OF VESSEL:

A. NAME (S): CBC 1700 THRU CBC 1709  
B. USCG PROJECT NUMBER: P021996  
C. DIMENSIONS: 200'-0" X 54'-0" X 12'-0"  
D. SERVICE: TANK BARGE (O/D)  
E. MAX. DESIGN WORKING PRESSURE: 3.5 PSIG  
F. PV VALVE PRESSURE SETTING: 1.5 PSIG  
G. PV VALVE VACUUM SETTING: 0.5 PSIG  
H. MAX. DISCHARGE RATE: 800 BBLS/HR

### 2. VAPOR CONTROL SYSTEM

A. PIPE DIAMETER: 7.981 INCHES IPS  
B. PIPE LENGTHS: A- 2'-1 1/4" B-5'-7" C-2'-4 1/64" D-37'-0 25/64", E-8'-3 61/64"  
F- 39'-11 39/64" G-47'-4 9/16" H-10'-0" I-17'-5 1/8"

### C. PV VALVE VENTING CAPACITY:

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

### D. SPILL VALVE RELIEVING CAPACITY:

NON INSTALLED

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

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

### F. MAX. LIQUID LOADING RATE:

3500 BBLS/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 heighest vapor growth rate (see Table 1)

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

Tank 1 is the farthest tank from the P/V valve. Using Crane's Technical Paper No. 410, the total equivalent length (L) for the path is shown in Table 2.

TABLE 2

| PIPE/FITTINGS | QUANTITY | UNIT EQ. LENGTH (FT) | TOTAL EQ. LENGTH (FT) |
|---------------|----------|----------------------|-----------------------|
| Straight Pipe | 1        | 104.664              | 104.664               |
| 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    |                      | 421.034               |

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

Using a 3500 bbl/h liquid transfer rate, the vapor-air mixture and air-equivalent volumetric flow rate for each cargo are given in Table 1 & Table 4. At a setting of 1.5 psig, the Bergan KLPH-6 PV Valve has an adequate pressure relieving capacity of air for each cargo listed in Table 1 & Table 4. The greatest pressure drop in the venting system (1.694 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 0.512 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 0.512 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.**

See Attached Calculations

**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        | 179.471                 | 179.471                  |
| Entrance      | 1        | 37.05                   | 37.05                    |
| T Branch      | 4        | 39.91                   | 159.64                   |
| T Run         | 9        | 13.33                   | 119.97                   |
| 8" Gate Valve | 1        | 5.32                    | 5.32                     |
|               |          | Total                   | 501.451                  |

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

TABLE 1 (SUB CHAPTER "D" CARGOES)

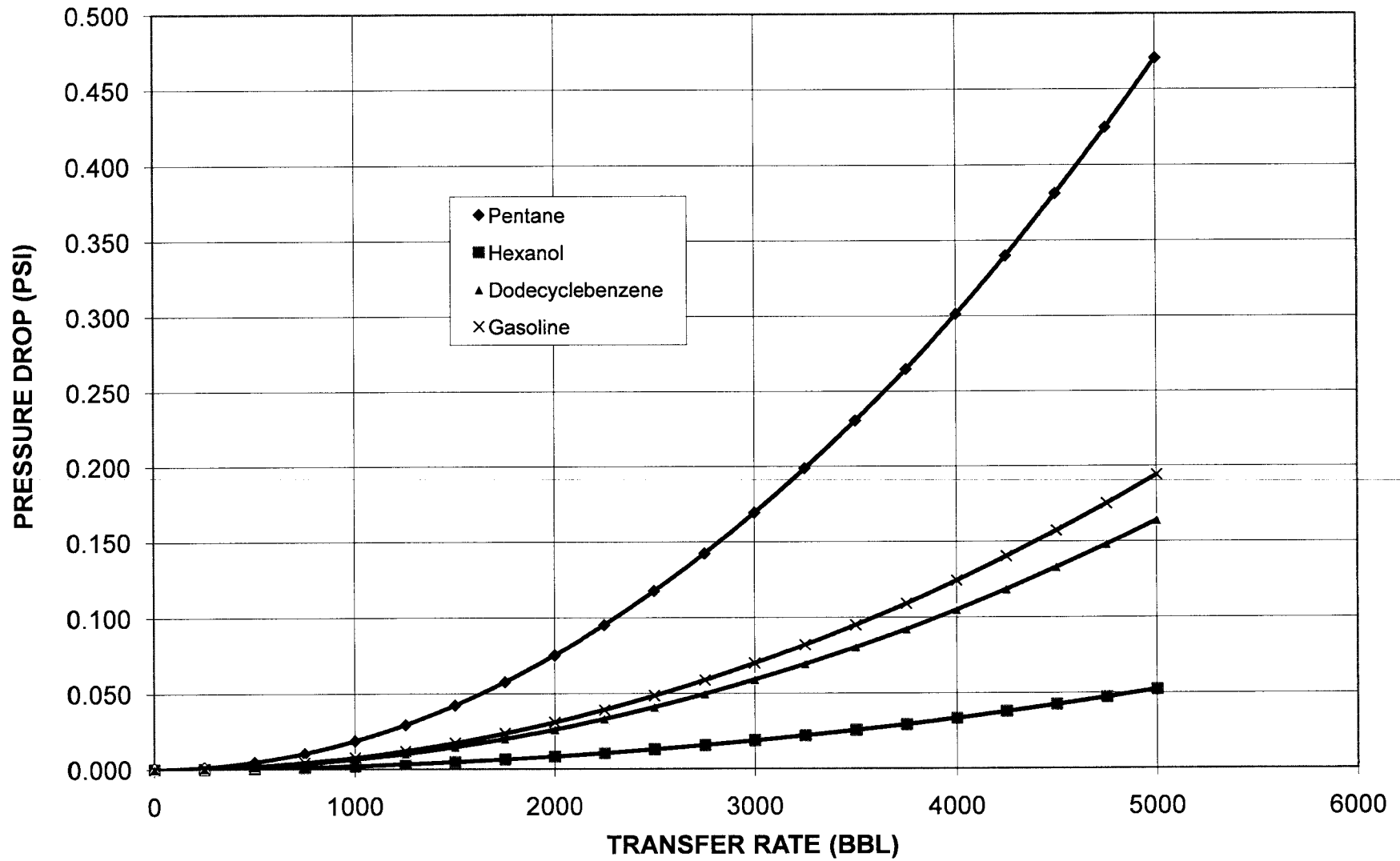
| CHRIS<br>CODE | NAME                                                  | VCS<br>CAT | LIQ<br>SG | VAPOR<br>PRESS | VAPOR<br>SG | VAPOR<br>AIR<br>WEIGHT<br>DENSITY | VAPOR<br>GROWTH<br>RATE | PRESSURE<br>DROP TO PV<br>VALVE IN<br>VCS(psig)<br>(LOADING) | VAPOR<br>VOLUMETRIC<br>FLOW RATE<br>(bbl/h) | AIR<br>EQUIVALENT<br>VOLUMETRIC<br>FLOW RATE | PRESSURE<br>DROP TO<br>SHORE<br>CONNECTION<br>IN VCS (psig)<br>(LOADING)* | PRESSURE<br>DROP TO PV<br>VALVE IN<br>VCS(psig)<br>(UNLOADING) | PRESSURE<br>DROP TO<br>SHORE<br>CONNECTION<br>IN VCS (psig)<br>(UNLOADING)* |
|---------------|-------------------------------------------------------|------------|-----------|----------------|-------------|-----------------------------------|-------------------------|--------------------------------------------------------------|---------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------|-----------------------------------------------------------------------------|
| 1 ACT         | Acetone                                               | 1          | 0.79      | 10             | 2           | 0.123                             | 1.2000                  | 0.042                                                        | 4200                                        | 5340                                         | 0.050                                                                     | 0.002                                                          | 0.003                                                                       |
| 2 ACP         | Acetophenone                                          | 1          | 1.03      | 0.6            | 4.14        | 0.085                             | 1.0120                  | 0.020                                                        | 3542                                        | 3741                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 19 AAT        | Amyl Acetate (iso-)                                   | 1          | 0.88      | 0.33           | 4.48        | 0.081                             | 1.0066                  | 0.019                                                        | 3523                                        | 3645                                         | 0.023                                                                     | 0.001                                                          | 0.001                                                                       |
| 20 AAI        | Amyl Alcohol (iso-, n-, sec-, primary) (See also IAA) | 1          | 0.82      | 0.3            | 3.04        | 0.079                             | 1.0060                  | 0.019                                                        | 3521                                        | 3586                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 21 AAN        | Amyl Alcohol (n-)                                     | 1          | 0.82      | 0.3            | 3.04        | 0.079                             | 1.0060                  | 0.019                                                        | 3521                                        | 3586                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 23 APM        | Amyl Alcohol, Primary                                 | 1          | 0.82      | 0.3            | 3.04        | 0.079                             | 1.0060                  | 0.019                                                        | 3521                                        | 3586                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 24 ASE        | Amyl Alcohol, (sec-)                                  | 1          | 0.82      | 0.3            | 3.04        | 0.079                             | 1.0060                  | 0.019                                                        | 3521                                        | 3586                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 26 IAA        | Amyl Alcohol, (iso-)                                  | 1          | 0.82      | 0.3            | 3.04        | 0.079                             | 1.0060                  | 0.019                                                        | 3521                                        | 3586                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 34 BAL        | Benzyl Alcohol                                        | 1          | 1.05      | 0.1            | 3.73        | 0.077                             | 1.0020                  | 0.018                                                        | 3507                                        | 3535                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 40 BAX        | Butyl Acetate (iso-, n-)                              | 1          | 0.87      | 0.6            | 4           | 0.084                             | 1.0120                  | 0.020                                                        | 3542                                        | 3733                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 42 BTA        | Butyl Acetate (sec-)                                  | 1          | 0.89      | 1.5            | 4           | 0.097                             | 1.0300                  | 0.024                                                        | 3605                                        | 4074                                         | 0.029                                                                     | 0.001                                                          | 0.002                                                                       |
| 44 IAL        | Butyl Alcohol (iso-)                                  | 1          | 0.81      | 0.9            | 2.6         | 0.083                             | 1.0180                  | 0.020                                                        | 3563                                        | 3717                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 46 BAS        | Butyl Alcohol (sec-)                                  | 1          | 0.81      | 1.3            | 2.6         | 0.086                             | 1.0260                  | 0.021                                                        | 3591                                        | 3814                                         | 0.025                                                                     | 0.001                                                          | 0.001                                                                       |
| 47 BAT        | Butyl Alcohol (tert-)                                 | 1          | 0.78      | 2.8            | 2.6         | 0.097                             | 1.0560                  | 0.026                                                        | 3696                                        | 4175                                         | 0.030                                                                     | 0.001                                                          | 0.002                                                                       |
| 48 BPH        | Butyl Benzyl Phthalate                                | 1          | 1.12      | 0.01           | 10.8        | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3510                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 64 CLS        | Caprolactam Solutions                                 | 1          | 1.02      | 0.05           | 3.9         | 0.077                             | 1.0010                  | 0.018                                                        | 3504                                        | 3518                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 70 CUM        | Cumene                                                | 1          | 0.86      | 0.60           | 4.20        | 0.085                             | 1.0120                  | 0.021                                                        | 3542                                        | 3745                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 72 CHX        | Cyclohexane                                           | 1          | 0.78      | 4.5            | 2.9         | 0.116                             | 1.0900                  | 0.033                                                        | 3815                                        | 4714                                         | 0.039                                                                     | 0.002                                                          | 0.002                                                                       |
| 73 CHN        | Cyclohexanol                                          | 1          | 0.95      | 0.15           | 3.45        | 0.078                             | 1.0030                  | 0.018                                                        | 3511                                        | 3549                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 74 CPD        | 1,3-Cyclopentadiene dimer (molten)                    | 1          | 0.69      | 0.25           | 4.55        | 0.080                             | 1.0050                  | 0.019                                                        | 3518                                        | 3612                                         | 0.023                                                                     | 0.001                                                          | 0.001                                                                       |
| 76 CMP        | Cymene (para-)                                        | 1          | 0.86      | 0.11           | 4.62        | 0.078                             | 1.0022                  | 0.018                                                        | 3508                                        | 3550                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 77 DHN        | Decahydronaphthalene                                  | 1          | 0.89      | 0.1            | 4.76        | 0.078                             | 1.0020                  | 0.018                                                        | 3507                                        | 3546                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 78 IDA        | Decaldehyde (iso-)                                    | 1          | 0.83      | 0.01           | 5           | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3504                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 79 DAL        | Decaldehyde (n-)                                      | 1          | 0.83      | 0              | 5.01        | 0.076                             | 1.0000                  | 0.018                                                        | 3500                                        | 3499                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 81 DCE        | Decane                                                | 1          | 0.74      | 0.12           | 4.8         | 0.078                             | 1.0024                  | 0.019                                                        | 3508                                        | 3556                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 82 DAX        | Decyl Alcohol (all isomers) (Decanol)                 | 1          | 0.83      | 0.01           | 5.3         | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3504                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 83 ISA        | Decyl Alcohol (iso-)                                  | 1          | 0.83      | 0.01           | 5.3         | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3504                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 84 DAN        | Decyl Alcohol (n-)                                    | 1          | 0.83      | 0.01           | 5.3         | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3504                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 85 DBZ        | Decylbenzene (n-)                                     | 1          | 0.86      | 0.01           | 7.52        | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3507                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 87 DAA        | Diacetone Alcohol                                     | 1          | 0.97      | 0.1            | 4           | 0.077                             | 1.0020                  | 0.018                                                        | 3507                                        | 3538                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 91 DPA        | Dibutyl Phthalate (ortho-)                            | 1          | 1.05      | 0              | 9.59        | 0.076                             | 1.0000                  | 0.018                                                        | 3500                                        | 3499                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 92 DPT        | Dicyclopentadiene, See 1,3-Cyclopentadiene Dimer      | 2          | 0.98      | 0.25           | 4.55        | 0.080                             | 1.0050                  | 0.019                                                        | 3518                                        | 3612                                         | 0.023                                                                     | 0.001                                                          | 0.001                                                                       |
| 93 DEB        | Diethylbenzene                                        | 1          | 0.87      | 0.08           | 4.62        | 0.077                             | 1.0016                  | 0.018                                                        | 3506                                        | 3536                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 94 DEG        | Diethylene Glycol                                     | 1          | 1.12      | 0.01           | 3.66        | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3503                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 95 DME        | Diethylene Glycol Butyl Ether                         | 1          | 0.95      | 0.01           | 5.5         | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3505                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 100 DGA       | Diethylene Glycol Ethyl Ether Acetate                 | 1          | 0.99      | 0.02           | 4.62        | 0.076                             | 1.0004                  | 0.018                                                        | 3501                                        | 3508                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 101 DGM       | Diethylene Glycol Methyl Ether                        | 1          | 1.03      | 0.03           | 4.14        | 0.076                             | 1.0006                  | 0.018                                                        | 3502                                        | 3511                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 111 DBC       | Diisobutylcarbinol                                    | 1          | 0.81      | 0.09           | 4.97        | 0.078                             | 1.0018                  | 0.018                                                        | 3506                                        | 3544                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 112 DBL       | Diisobutylene                                         | 1          | 0.72      | 2              | 3.86        | 0.103                             | 1.0400                  | 0.026                                                        | 3640                                        | 4233                                         | 0.031                                                                     | 0.001                                                          | 0.002                                                                       |
| 113 DIX       | Diisobutyl Ketone                                     | 1          | 0.81      | 0.16           | 4.9         | 0.079                             | 1.0032                  | 0.019                                                        | 3511                                        | 3577                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 119 DIX       | Diisopropylbenzene (all isomer)                       | 1          | 0.86      | 0.03           | 5.6         | 0.077                             | 1.0006                  | 0.018                                                        | 3502                                        | 3516                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 124 DTL       | Dimethyl Phthalate                                    | 1          | 1.19      | 0              | 6.69        | 0.076                             | 1.0000                  | 0.018                                                        | 3500                                        | 3499                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 130 DOP       | Diethyl Phthalate                                     | 1          | 0.98      | 0              | 13.47       | 0.076                             | 1.0000                  | 0.018                                                        | 3500                                        | 3499                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 131 DPN       | Dipentene                                             | 1          | 0.84      | 0.1            | 4.9         | 0.078                             | 1.0020                  | 0.018                                                        | 3507                                        | 3548                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 132 DIL       | Diphenyl                                              | 1          | 0.99      | 0.01           | 5.31        | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3504                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 133 DDO       | Diphenyl, Diphenyl Ether Mixture                      | 1          | 1.07      | 0.01           | 5.86        | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3505                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 134 DPE       | Diphenyl Ether                                        | 1          | 1.07      | 0.01           | 5.87        | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3505                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 136 DPG       | Dipropylene Glycol                                    | 1          | 1.03      | 0.07           | 4.63        | 0.077                             | 1.0014                  | 0.018                                                        | 3505                                        | 3531                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 139 DFF       | Distillates: Flashed Feed Stocks                      | 1          | 0.75      | 2.3            | 3.4         | 0.102                             | 1.0460                  | 0.026                                                        | 3661                                        | 4238                                         | 0.031                                                                     | 0.001                                                          | 0.002                                                                       |
| 140 DSR       | Distillates: Straight Run                             | 1          | 0.73      | 2.3            | 3.4         | 0.102                             | 1.0460                  | 0.026                                                        | 3661                                        | 4238                                         | 0.031                                                                     | 0.001                                                          | 0.002                                                                       |
| 145 DOZ       | Dodecene (all isomers)                                | 1          | 0.76      | 0.02           | 5.81        | 0.076                             | 1.0004                  | 0.018                                                        | 3501                                        | 3511                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 146 DOD       | Dodecene                                              | 1          | 0.76      | 0.02           | 5.81        | 0.076                             | 1.0004                  | 0.018                                                        | 3501                                        | 3511                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 147 DDB       | Dodecylbenzene                                        | 1          | 0.86      | 4.7            | 8.4         | 0.239                             | 1.0940                  | 0.068                                                        | 3829                                        | 6791                                         | 0.080                                                                     | 0.004                                                          | 0.004                                                                       |
| 155 ETG       | Ethoxy Triglycol (crude)                              | 1          | 1.02      | 0              | 6.14        | 0.076                             | 1.0000                  | 0.018                                                        | 3500                                        | 3499                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 156 ETA       | Ethyl Acetate                                         | 1          | 0.9       | 4.5            | 3.04        | 0.119                             | 1.0900                  | 0.033                                                        | 3815                                        | 4774                                         | 0.040                                                                     | 0.002                                                          | 0.002                                                                       |
| 157 EAA       | Ethyl Acetoacetate                                    | 1          | 1.03      | 0.2            | 4.48        | 0.079                             | 1.0040                  | 0.019                                                        | 3514                                        | 3588                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 158 EAL       | Ethyl Alcohol (Ethanol)                               | 1          | 0.79      | 3.5            | 1.6         | 0.086                             | 1.0700                  | 0.023                                                        | 3745                                        | 3979                                         | 0.028                                                                     | 0.001                                                          | 0.001                                                                       |
| 160 ETB       | Ethyl Benzene                                         | 1          | 0.87      | 0.6            | 3.56        | 0.083                             | 1.0120                  | 0.020                                                        | 3542                                        | 3705                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 161 EBT       | Ethyl Butanol                                         | 1          | 0.83      | 0.12           | 3.52        | 0.077                             | 1.0024                  | 0.018                                                        | 3508                                        | 3540                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 162 EBR       | Ethyl Butyrate                                        | 1          | 0.88      | 1              | 4           | 0.090                             | 1.0200                  | 0.022                                                        | 3570                                        | 3885                                         | 0.026                                                                     | 0.001                                                          | 0.001                                                                       |
| 163 ECY       | Ethyl Cyclohexane                                     | 1          | 0.79      | 0.5            | 3.87        | 0.083                             | 1.0100                  | 0.020                                                        | 3535                                        | 3687                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 166 EGL       | Ethylene Glycol                                       | 1          | 1.19      | 0.01           | 2.21        | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3501                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 169 EMA       | Ethylene Glycol Butyl Ether Acetate                   | 1          | 0.94      | 0.05           | 5.52        | 0.077                             | 1.0010                  | 0.018                                                        | 3504                                        | 3527                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |

|     |     |                                                           |   |      |       |      |       |        |       |      |      |       |       |       |
|-----|-----|-----------------------------------------------------------|---|------|-------|------|-------|--------|-------|------|------|-------|-------|-------|
| 172 | EGY | Ethylene Glycol Diacetate                                 | 1 | 1.1  | 0.01  | 5.03 | 0.076 | 1.0002 | 0.018 | 3501 | 3504 | 0.021 | 0.001 | 0.001 |
| 178 | EME | Ethylene Glycol Methyl Ether                              | 1 | 1.1  | 0.01  | 4.8  | 0.076 | 1.0002 | 0.018 | 3501 | 3504 | 0.021 | 0.001 | 0.001 |
| 180 | EPE | Ethylene Glycol Phenyl Ether                              | 1 | 1.1  | 0.01  | 4.8  | 0.076 | 1.0002 | 0.018 | 3501 | 3504 | 0.021 | 0.001 | 0.001 |
| 184 | EHA | 2-Ethylhexaldehyde, See Octyl Aldehydes                   | 1 | 0.82 | 0.17  | 4.41 | 0.079 | 1.0034 | 0.019 | 3512 | 3573 | 0.022 | 0.001 | 0.001 |
| 186 | EHX | 2-Ethylhexanol, see Octanol (all isomers)                 | 1 | 0.84 | 0.02  | 4.5  | 0.076 | 1.0004 | 0.018 | 3501 | 3508 | 0.021 | 0.001 | 0.001 |
| 190 | EPR | Ethyl Propionate                                          | 1 | 0.89 | 3.5   | 1.6  | 0.086 | 1.0700 | 0.023 | 3745 | 3979 | 0.028 | 0.001 | 0.001 |
| 191 | ETE | Ethyl Toulene                                             | 1 | 0.88 | 0.28  | 4.15 | 0.080 | 1.0056 | 0.019 | 3520 | 3613 | 0.023 | 0.001 | 0.001 |
| 194 | FAM | Formamide                                                 | 1 | 1.13 | 0.1   | 1.55 | 0.076 | 1.0020 | 0.018 | 3507 | 3512 | 0.022 | 0.001 | 0.001 |
| 195 | FAL | Furfuryl Alcohol                                          | 1 | 1.13 | 0.05  | 3.4  | 0.077 | 1.0010 | 0.018 | 3504 | 3515 | 0.022 | 0.001 | 0.001 |
| 197 | GAK | Gasoline Blended Stocks: Alkylates                        | 1 | 0.75 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.095 | 0.004 | 0.005 |
| 198 | GRF | Gasoline Blended Stocks: Reformate                        | 1 | 0.8  | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.095 | 0.004 | 0.005 |
| 199 | GAT | Gasolines: Automotive (containing not over 4.23 grs 1     | 1 | 0.74 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.095 | 0.004 | 0.005 |
| 200 | GAV | Gasolines: Aviation (containing not over 4.86 grams 1     | 1 | 0.71 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.095 | 0.004 | 0.005 |
| 201 | GCS | Gasolines: Casinghead                                     | 1 | 0.67 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.095 | 0.004 | 0.005 |
| 202 | GPL | Gasolines: Polymer                                        | 1 | 0.75 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.095 | 0.004 | 0.005 |
| 203 | GSR | Gasolines: Straight Run                                   | 1 | 0.75 | 12.5  | 3.4  | 0.217 | 1.2500 | 0.080 | 4375 | 7386 | 0.095 | 0.004 | 0.005 |
| 204 | GCR | Glycerine                                                 | 1 | 1.26 | 0     | 3.17 | 0.076 | 1.0000 | 0.018 | 3500 | 3499 | 0.021 | 0.001 | 0.001 |
| 217 | HMX | Heptane (all isomers) (Methylhexane)                      | 1 | 0.68 | 2.5   | 3.45 | 0.105 | 1.0500 | 0.027 | 3675 | 4313 | 0.032 | 0.001 | 0.002 |
| 218 | HPT | Heptane (n-)                                              | 1 | 0.68 | 2.5   | 3.45 | 0.105 | 1.0500 | 0.027 | 3675 | 4313 | 0.032 | 0.001 | 0.002 |
| 220 | HTX | Heptanol (all isomers)                                    | 1 | 0.82 | 0.04  | 4    | 0.077 | 1.0008 | 0.018 | 3503 | 3515 | 0.022 | 0.001 | 0.001 |
| 221 | HTN | Heptanol (all isomers)                                    | 1 | 0.82 | 0.04  | 4    | 0.077 | 1.0008 | 0.018 | 3503 | 3515 | 0.022 | 0.001 | 0.001 |
| 222 | HPX | Heptene (all isomers)                                     | 2 | 0.7  | 2.9   | 3.4  | 0.109 | 1.0580 | 0.029 | 3703 | 4426 | 0.034 | 0.001 | 0.002 |
| 223 | THE | Heptene (1-)                                              | 1 | 0.7  | 2.8   | 3.4  | 0.107 | 1.0560 | 0.028 | 3696 | 4395 | 0.034 | 0.001 | 0.002 |
| 229 | HXS | Hexane (all isomers)                                      | 1 | 0.66 | 7     | 3    | 0.142 | 1.1400 | 0.043 | 3990 | 5446 | 0.052 | 0.002 | 0.003 |
| 230 | HXA | Hexane                                                    | 1 | 0.66 | 7     | 3    | 0.142 | 1.1400 | 0.043 | 3990 | 5446 | 0.052 | 0.002 | 0.003 |
| 231 | HXO | Hexanoic Acid                                             | 1 | 0.93 | 0.01  | 4    | 0.076 | 1.0002 | 0.018 | 3501 | 3503 | 0.021 | 0.001 | 0.001 |
| 232 | HXN | Hexanol                                                   | 1 | 0.82 | 1     | 3.52 | 0.088 | 1.0200 | 0.022 | 3570 | 3837 | 0.026 | 0.001 | 0.001 |
| 234 | HEX | Hexene (all isomers)                                      | 2 | 0.67 | 8     | 2.9  | 0.147 | 1.1600 | 0.047 | 4060 | 5651 | 0.056 | 0.002 | 0.003 |
| 235 | HXE | Hexene (1-)                                               | 1 | 0.67 | 8.2   | 2.9  | 0.149 | 1.1640 | 0.048 | 4074 | 5705 | 0.057 | 0.002 | 0.003 |
| 236 | HXT | Hexene (2-)                                               | 1 | 0.67 | 8.2   | 2.9  | 0.149 | 1.1640 | 0.048 | 4074 | 5705 | 0.057 | 0.002 | 0.003 |
| 238 | HXG | Hexylene Glycol                                           | 4 | 0.92 | 0.01  | 1.1  | 0.076 | 1.0002 | 0.018 | 3501 | 3500 | 0.021 | 0.001 | 0.001 |
| 243 | IPH | Isophorone                                                | 1 | 0.93 | 0.01  | 4.75 | 0.076 | 1.0002 | 0.018 | 3501 | 3504 | 0.021 | 0.001 | 0.001 |
| 244 | JPO | Jet Fuels: JP-1 (Kerosene)                                | 1 | 0.8  | 0.14  | 4.5  | 0.078 | 1.0028 | 0.019 | 3510 | 3561 | 0.022 | 0.001 | 0.001 |
| 245 | JPT | Jet Fuels: JP-3                                           | 1 | 0.8  | 8.51  | 4.5  | 0.216 | 1.1702 | 0.070 | 4096 | 6899 | 0.083 | 0.004 | 0.004 |
| 246 | JPF | Jet Fuels: JP-4                                           | 1 | 0.81 | 3.4   | 4    | 0.124 | 1.0680 | 0.033 | 3738 | 4770 | 0.040 | 0.002 | 0.002 |
| 247 | JPV | Jet Fuels: JP-5 (Kerosene, heavy)                         | 1 | 0.82 | 0.1   | 4    | 0.077 | 1.0020 | 0.018 | 3507 | 3538 | 0.022 | 0.001 | 0.001 |
| 249 | KRS | Kerosene                                                  | 1 | 0.81 | 0.15  | 4.5  | 0.078 | 1.0030 | 0.019 | 3511 | 3566 | 0.022 | 0.001 | 0.001 |
| 263 | MTT | Methyl Acetate                                            | 1 | 0.92 | 6.1   | 2.6  | 0.122 | 1.1220 | 0.036 | 3927 | 4970 | 0.043 | 0.002 | 0.002 |
| 265 | MAL | Methyl Alcohol (See Methanol)                             | 1 | 0.79 | 6.63  | 1.1  | 0.079 | 1.1326 | 0.024 | 3964 | 4043 | 0.029 | 0.001 | 0.001 |
| 266 | MAC | Methyl Amyl Acetate                                       | 1 | 0.86 | 0.33  | 4.97 | 0.082 | 1.0066 | 0.020 | 3523 | 3662 | 0.023 | 0.001 | 0.001 |
| 267 | MAA | Methyl Amyl Alcohol                                       | 1 | 0.81 | 0.43  | 3.52 | 0.081 | 1.0086 | 0.019 | 3530 | 3645 | 0.023 | 0.001 | 0.001 |
| 271 | MBK | Methyl n-Butyl Ketone                                     | 1 | 0.81 | 0.97  | 3.5  | 0.087 | 1.0194 | 0.021 | 3568 | 3825 | 0.026 | 0.001 | 0.001 |
| 273 | MBU | Methyl Butyrate                                           | 1 | 0.9  | 1.26  | 3.53 | 0.091 | 1.0252 | 0.023 | 3588 | 3924 | 0.027 | 0.001 | 0.001 |
| 274 | MEK | Methyl Ethyl Ketone                                       | 1 | 0.8  | 4.5   | 2.5  | 0.108 | 1.0900 | 0.030 | 3815 | 4539 | 0.036 | 0.002 | 0.002 |
| 275 | MTF | Methyl Formal (Dimethyl Formal)                           | 1 | 0.86 | 15.42 | 2.6  | 0.192 | 1.3084 | 0.077 | 4579 | 7272 | 0.092 | 0.004 | 0.005 |
| 276 | MHK | Methyl Heptyl Ketone                                      | 1 | 0.83 | 0.06  | 4.9  | 0.077 | 1.0012 | 0.018 | 3504 | 3528 | 0.022 | 0.001 | 0.001 |
| 278 | MIK | Methyl Isobutyl Ketone                                    | 1 | 0.8  | 1.15  | 3.45 | 0.089 | 1.0230 | 0.022 | 3581 | 3878 | 0.026 | 0.001 | 0.001 |
| 281 | MNA | 1-Methyl Napthalene                                       | 1 | 1.02 | 0.01  | 4.91 | 0.076 | 1.0002 | 0.018 | 3501 | 3504 | 0.021 | 0.001 | 0.001 |
| 283 | MPN | 2-Methyl-1-Pentene                                        | 1 | 0.69 | 6.3   | 2.9  | 0.132 | 1.1260 | 0.040 | 3941 | 5195 | 0.047 | 0.002 | 0.002 |
| 284 | MTN | 5-Methyl-1-Pentene                                        | 1 | 0.67 | 8.49  | 2.9  | 0.152 | 1.1698 | 0.049 | 4094 | 5782 | 0.058 | 0.003 | 0.003 |
| 286 | MBE | Methyl Tert-Butyl Ether (MTBE)                            | 1 | 0.74 | 0.04  | 3.1  | 0.076 | 1.0008 | 0.018 | 3503 | 3511 | 0.021 | 0.001 | 0.001 |
| 288 | MNS | Mineral Spirits                                           | 1 | 0.75 | 0.2   | 4.3  | 0.079 | 1.0040 | 0.019 | 3514 | 3584 | 0.022 | 0.001 | 0.001 |
| 289 | MRE | Myrcene                                                   | 1 | 0.8  | 0.17  | 4.7  | 0.079 | 1.0034 | 0.019 | 3512 | 3578 | 0.022 | 0.001 | 0.001 |
| 295 | NSV | Naphtha: Solvent                                          | 1 | 0.87 | 0.2   | 3.5  | 0.078 | 1.0040 | 0.019 | 3514 | 3567 | 0.022 | 0.001 | 0.001 |
| 296 | NSS | Naphtha: Stoddard Solvant                                 | 1 | 0.78 | 0.2   | 4.3  | 0.079 | 1.0040 | 0.019 | 3514 | 3584 | 0.022 | 0.001 | 0.001 |
| 297 | NVM | Naphtha: Varnish Maker's and Painters (75%)               | 1 | 0.77 | 0.19  | 4.3  | 0.079 | 1.0038 | 0.019 | 3513 | 3580 | 0.022 | 0.001 | 0.001 |
| 300 | NAX | Nonane (all isomers)                                      | 1 | 0.72 | 0.27  | 4.4  | 0.080 | 1.0054 | 0.019 | 3519 | 3616 | 0.023 | 0.001 | 0.001 |
| 301 | NAN | Nonane                                                    | 1 | 0.72 | 0.27  | 4.4  | 0.080 | 1.0054 | 0.019 | 3519 | 3616 | 0.023 | 0.001 | 0.001 |
| 304 | NON | Nonene                                                    | 1 | 0.73 | 0.35  | 4.3  | 0.081 | 1.0070 | 0.019 | 3525 | 3647 | 0.023 | 0.001 | 0.001 |
| 305 | NNS | Nonyl Alcohol (all isomers)                               | 1 | 0.94 | 0.1   | 5    | 0.078 | 1.0020 | 0.018 | 3507 | 3549 | 0.022 | 0.001 | 0.001 |
| 306 | NNN | Nonyl Alcohol                                             | 1 | 0.94 | 0.1   | 5    | 0.078 | 1.0020 | 0.018 | 3507 | 3549 | 0.022 | 0.001 | 0.001 |
| 307 | NNI | Nonyl Alcohol (iso-)                                      | 1 | 0.94 | 0.1   | 5    | 0.078 | 1.0020 | 0.018 | 3507 | 3549 | 0.022 | 0.001 | 0.001 |
| 309 | NNP | Nonyl Phenol                                              | 1 | 0.95 | 0.01  | 7.6  | 0.076 | 1.0002 | 0.018 | 3501 | 3507 | 0.021 | 0.001 | 0.001 |
| 316 | OAX | Octane (all isomers)                                      | 1 | 0.7  | 0.79  | 3.9  | 0.087 | 1.0158 | 0.021 | 3555 | 3797 | 0.025 | 0.001 | 0.001 |
| 317 | OAN | Octane                                                    | 1 | 0.7  | 0.79  | 3.9  | 0.087 | 1.0158 | 0.021 | 3555 | 3797 | 0.025 | 0.001 | 0.001 |
| 320 | OTA | Octanol                                                   | 1 | 0.83 | 0.01  | 4.48 | 0.076 | 1.0002 | 0.018 | 3501 | 3503 | 0.021 | 0.001 | 0.001 |
| 322 | OTE | Octene (1-)                                               | 1 | 0.72 | 1     | 3.86 | 0.089 | 1.0200 | 0.022 | 3570 | 3871 | 0.026 | 0.001 | 0.001 |
| 324 | OCX | Octyl Alcohol (iso-, n-) ( all isomers), See Octanol (ε 1 | 1 | 0.83 | 0.01  | 4.48 | 0.076 | 1.0002 | 0.018 | 3501 | 3503 | 0.021 | 0.001 | 0.001 |
| 325 | IOA | Octyl Alcohol                                             | 1 | 0.83 | 0.01  | 4.48 | 0.076 | 1.0002 | 0.018 | 3501 | 3503 | 0.021 | 0.001 | 0.001 |
| 364 | OTW | Fuel: No. 2                                               | 1 | 0.88 | 0.56  | 8    | 0.094 | 1.0112 | 0.023 | 3539 | 3943 | 0.027 | 0.001 | 0.001 |

|         |                                                        |   |       |        |        |       |        |       |      |       |       |       |       |
|---------|--------------------------------------------------------|---|-------|--------|--------|-------|--------|-------|------|-------|-------|-------|-------|
| 366 OFR | Fuel: No. 4                                            | 1 | 0.9   | 0.15   | 3.4    | 0.078 | 1.0030 | 0.018 | 3511 | 3548  | 0.022 | 0.001 | 0.001 |
| 367 OFV | Fuel: No. 5                                            | 1 | 0.94  | 0.15   | 3.4    | 0.078 | 1.0030 | 0.018 | 3511 | 3548  | 0.022 | 0.001 | 0.001 |
| 368 OSX | Fuel: No. 6                                            | 1 | 0.95  | 0.15   | 3.4    | 0.078 | 1.0030 | 0.018 | 3511 | 3548  | 0.022 | 0.001 | 0.001 |
| 382 OIL | OIL, Misc: Crude                                       | 1 | 0.95  | 0.15   | 3.4    | 0.078 | 1.0030 | 0.018 | 3511 | 3548  | 0.022 | 0.001 | 0.001 |
| 383 ODS | OIL, Misc: Diesel                                      | 1 | 0.9   | 0.69   | 3.4    | 0.084 | 1.0138 | 0.020 | 3548 | 3724  | 0.024 | 0.001 | 0.001 |
| 389 OLB | OIL, Misc: Lubricating                                 | 1 | 0.9   | 0.15   | 1      | 0.076 | 1.0030 | 0.018 | 3511 | 3510  | 0.021 | 0.001 | 0.001 |
| 403 ORS | OIL, Misc: Resin                                       | 1 | 1.02  | 0.15   | 1      | 0.076 | 1.0030 | 0.018 | 3511 | 3510  | 0.021 | 0.001 | 0.001 |
| 418 OTB | OIL, Misc: Turbine                                     | 1 | 0.87  | 0.3    | 5.4    | 0.082 | 1.0060 | 0.020 | 3521 | 3661  | 0.023 | 0.001 | 0.001 |
| 429 PDC | Pentadecanol, See Alcohols (C13 and above)             | 1 | 0.83  | 0.01   | 7.88   | 0.076 | 1.0002 | 0.018 | 3501 | 3507  | 0.021 | 0.001 | 0.001 |
| 433 IPT | Pentane (iso-)                                         | 5 | 0.62  | 27     | 2.48   | 0.346 | 1.5400 | 0.194 | 5390 | 11501 | 0.231 | 0.010 | 0.012 |
| 434 PTA | Pentane (n-)                                           | 5 | 0.63  | 20.44  | 2.5    | 0.264 | 1.4088 | 0.124 | 4931 | 9191  | 0.147 | 0.006 | 0.008 |
| 437 PTE | Pentene (1-)                                           | 5 | 0.64  | 24.9   | 2.4    | 0.309 | 1.4980 | 0.164 | 5243 | 10568 | 0.195 | 0.009 | 0.010 |
| 442 PIN | Pinene                                                 | 1 | 0.86  | 0.35   | 4.7    | 0.082 | 1.0070 | 0.020 | 3525 | 3662  | 0.023 | 0.001 | 0.001 |
| 448 PLB | Polybutene                                             | 1 | 0.91  | 0.01   | 79.3   | 0.080 | 1.0002 | 0.019 | 3501 | 3583  | 0.022 | 0.001 | 0.001 |
| 457 PGC | Polypropylene Glycol                                   | 1 | 1.01  | 0.1    | 1      | 0.076 | 1.0020 | 0.018 | 3507 | 3506  | 0.021 | 0.001 | 0.001 |
| 464 IAC | Propyl Acetate (iso-)                                  | 1 | 0.89  | 1.8    | 3.52   | 0.097 | 1.0360 | 0.025 | 3626 | 4101  | 0.029 | 0.001 | 0.002 |
| 465 PAT | Propyl Acetate (n-)                                    | 1 | 0     | 1.85   | 3.52   | 0.098 | 1.0370 | 0.025 | 3630 | 4118  | 0.030 | 0.001 | 0.002 |
| 466 IPA | Propyl Alcohol (iso-)                                  | 1 | 0.79  | 3      | 2.07   | 0.091 | 1.0600 | 0.024 | 3710 | 4060  | 0.029 | 0.001 | 0.002 |
| 467 PAL | Propyl Alcohol (n-)                                    | 1 | 0.8   | 1.2    | 2.07   | 0.082 | 1.0240 | 0.020 | 3584 | 3722  | 0.024 | 0.001 | 0.001 |
| 468 PBZ | Propylbenzene (n-)                                     | 1 | 0.86  | 0.2    | 4.14   | 0.079 | 1.0040 | 0.019 | 3514 | 3580  | 0.022 | 0.001 | 0.001 |
| 469 IPX | Iso-Propylcyclohexane                                  | 1 | 0.8   | 0.01   | 4.35   | 0.076 | 1.0002 | 0.018 | 3501 | 3503  | 0.021 | 0.001 | 0.001 |
| 473 PPG | Propylene Glycol (1,2-Propandiol)                      | 1 | 1.04  | 0.01   | 2.62   | 0.076 | 1.0002 | 0.018 | 3501 | 3501  | 0.021 | 0.001 | 0.001 |
| 476 PME | Propylene Glycol Methyl Ether                          | 1 | 0.92  | 0.7    | 3.11   | 0.083 | 1.0140 | 0.020 | 3549 | 3706  | 0.024 | 0.001 | 0.001 |
| 488 SFL | Sulfolane                                              | 1 | 1.26  | 0.01   | 4.14   | 0.076 | 1.0002 | 0.018 | 3501 | 3503  | 0.021 | 0.001 | 0.001 |
| 493 TTN | Tetradecanol                                           | 1 | 0.82  | 0      | 7.39   | 0.076 | 1.0000 | 0.018 | 3500 | 3499  | 0.021 | 0.001 | 0.001 |
| 494 TTD | 1-Tetradecene, See the olefin or Alpha-Olefin Entries  | 1 | 0.77  | 0.01   | 6.77   | 0.076 | 1.0002 | 0.018 | 3501 | 3506  | 0.021 | 0.001 | 0.001 |
| 496 TTG | Tetraethylene Glycol                                   | 1 | 1.12  | 0.01   | 6.7    | 0.076 | 1.0002 | 0.018 | 3501 | 3506  | 0.021 | 0.001 | 0.001 |
| 497 THN | Tetrahydronaphthalene                                  | 1 | 0.97  | 0.04   | 4.56   | 0.077 | 1.0008 | 0.018 | 3503 | 3517  | 0.022 | 0.001 | 0.001 |
| 499 TOL | Toluene                                                | 1 | 0.87  | 1.5    | 3.14   | 0.091 | 1.0300 | 0.023 | 3605 | 3945  | 0.027 | 0.001 | 0.001 |
| 502 TCP | Tricresyl Phosphate (less than 1% of the ortho isomer) | 1 | 1.16  | 0.01   | 12.69  | 0.077 | 1.0002 | 0.018 | 3501 | 3512  | 0.022 | 0.001 | 0.001 |
| 503 TRD | Tridecane                                              | 1 | 0.76  | 0.02   | 6.4    | 0.076 | 1.0004 | 0.018 | 3501 | 3512  | 0.022 | 0.001 | 0.001 |
| 505 TDN | Tridecanol, See Alcohols (C13 and above)               | 1 | 0.85  | 0.01   | 6.91   | 0.076 | 1.0002 | 0.018 | 3501 | 3506  | 0.021 | 0.001 | 0.001 |
| 506 TDC | 1-Tridecene                                            | 1 | 0.77  | 0.01   | 6.29   | 0.076 | 1.0002 | 0.018 | 3501 | 3505  | 0.021 | 0.001 | 0.001 |
| 508 TEB | Triethylbenzene                                        | 1 | 0.86  | 0.02   | 5.6    | 0.076 | 1.0004 | 0.018 | 3501 | 3510  | 0.021 | 0.001 | 0.001 |
| 509 TEG | Triethylene Glycol                                     | 1 | 1.12  | 0.01   | 5.17   | 0.076 | 1.0002 | 0.018 | 3501 | 3504  | 0.021 | 0.001 | 0.001 |
| 519 TRE | Trimethylbenzenes (all isomers)                        | 1 | 0.89  | 0.14   | 4.2    | 0.078 | 1.0028 | 0.019 | 3510 | 3557  | 0.022 | 0.001 | 0.001 |
| 520 TMB | Trimethyl Benzene (1,2,5-)                             | 1 | 0.89  | 0.14   | 4.14   | 0.078 | 1.0028 | 0.019 | 3510 | 3556  | 0.022 | 0.001 | 0.001 |
| 521 TMD | Trimethyl Benzene (1,2,3-)                             | 1 | 0.89  | 0.14   | 4.14   | 0.078 | 1.0028 | 0.019 | 3510 | 3556  | 0.022 | 0.001 | 0.001 |
| 522 TME | Trimethyl Benzene (1,2,4-) (Pseudocumene)              | 1 | 0.89  | 0.14   | 4.14   | 0.078 | 1.0028 | 0.019 | 3510 | 3556  | 0.022 | 0.001 | 0.001 |
| 529 TRP | Trixylenyl Phosphate                                   | 1 | 1.16  | 0      | 14.2   | 0.076 | 1.0000 | 0.018 | 3500 | 3499  | 0.021 | 0.001 | 0.001 |
| 546 XLX | Xylenes (Ortho-, meta-, para-)                         | 1 | 0.89  | 0.51   | 3.66   | 0.082 | 1.0102 | 0.020 | 3536 | 3680  | 0.024 | 0.001 | 0.001 |
| 547 XLM | Xylene (M-)                                            | 1 | 0.87  | 0.51   | 3.66   | 0.082 | 1.0102 | 0.020 | 3536 | 3680  | 0.024 | 0.001 | 0.001 |
| 548 XLO | Xylene (O-)                                            | 1 | 0.89  | 0.4    | 3.66   | 0.081 | 1.0080 | 0.019 | 3528 | 3641  | 0.023 | 0.001 | 0.001 |
| 549 XLP | Xylene (P-)                                            | 1 | 0.86  | 0.51   | 3.66   | 0.082 | 1.0102 | 0.020 | 3536 | 3680  | 0.024 | 0.001 | 0.001 |
| 550 XYL | Xylenol                                                | 1 | 1.01  | 0.1    | 3.66   | 0.077 | 1.0020 | 0.018 | 3507 | 3535  | 0.022 | 0.001 | 0.001 |
| 551     | Zinc Dialkyldithiophosphate                            |   |       |        |        |       |        |       |      |       |       |       |       |
|         | Max.                                                   |   | 1.260 | 27.000 | 79.300 | 0.346 | 1.540  | 0.194 | 5390 | 11501 | 0.231 | 0.010 | 0.012 |
|         | Min.                                                   |   | 0.000 | 0.000  | 1.000  | 0.000 | 1.000  | 0.018 | 3500 | 3499  | 0.021 | 0.000 | 0.000 |

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

# LIQUID TRANSFER RATE vs PRESSURE DROP



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

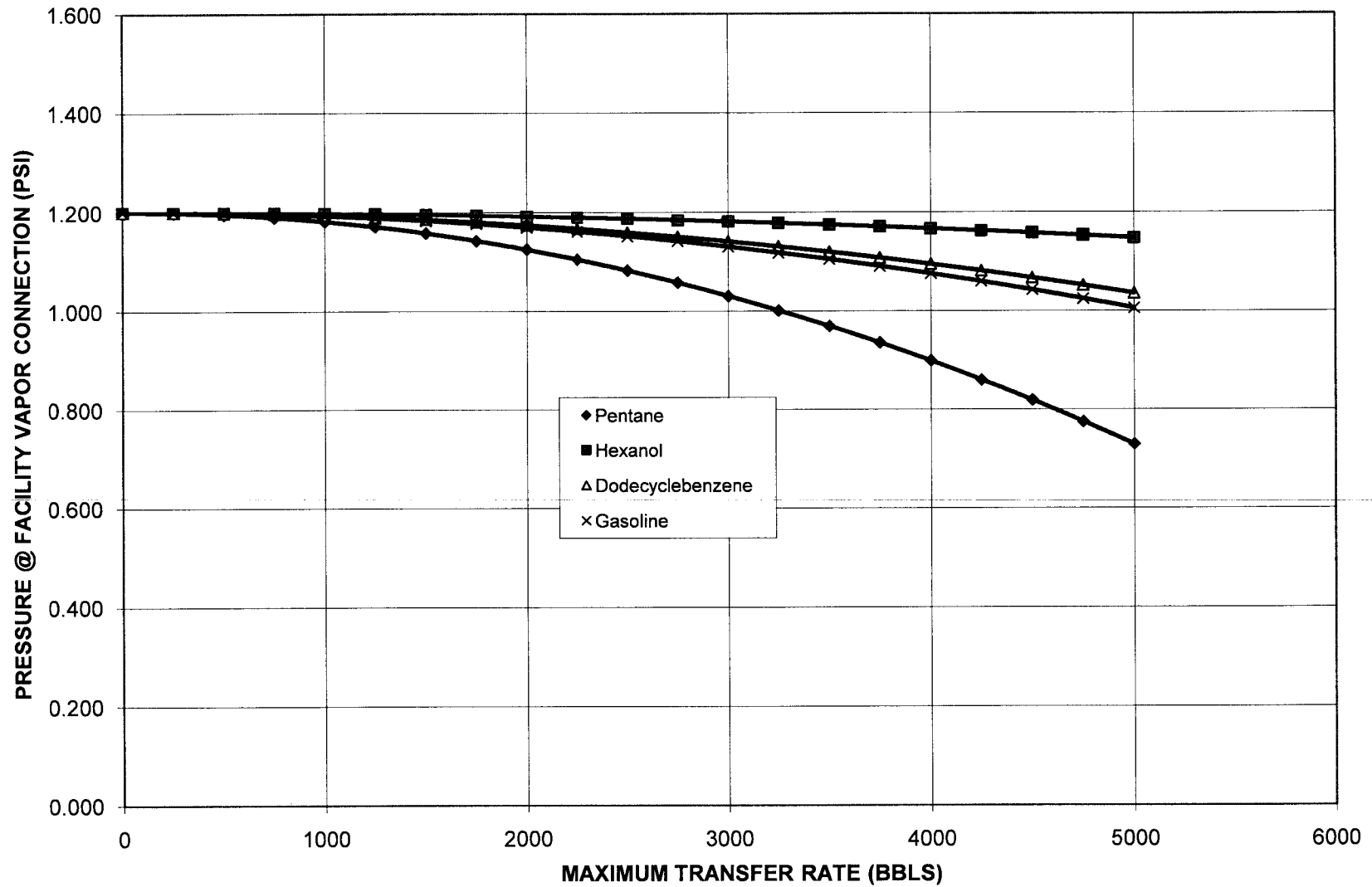
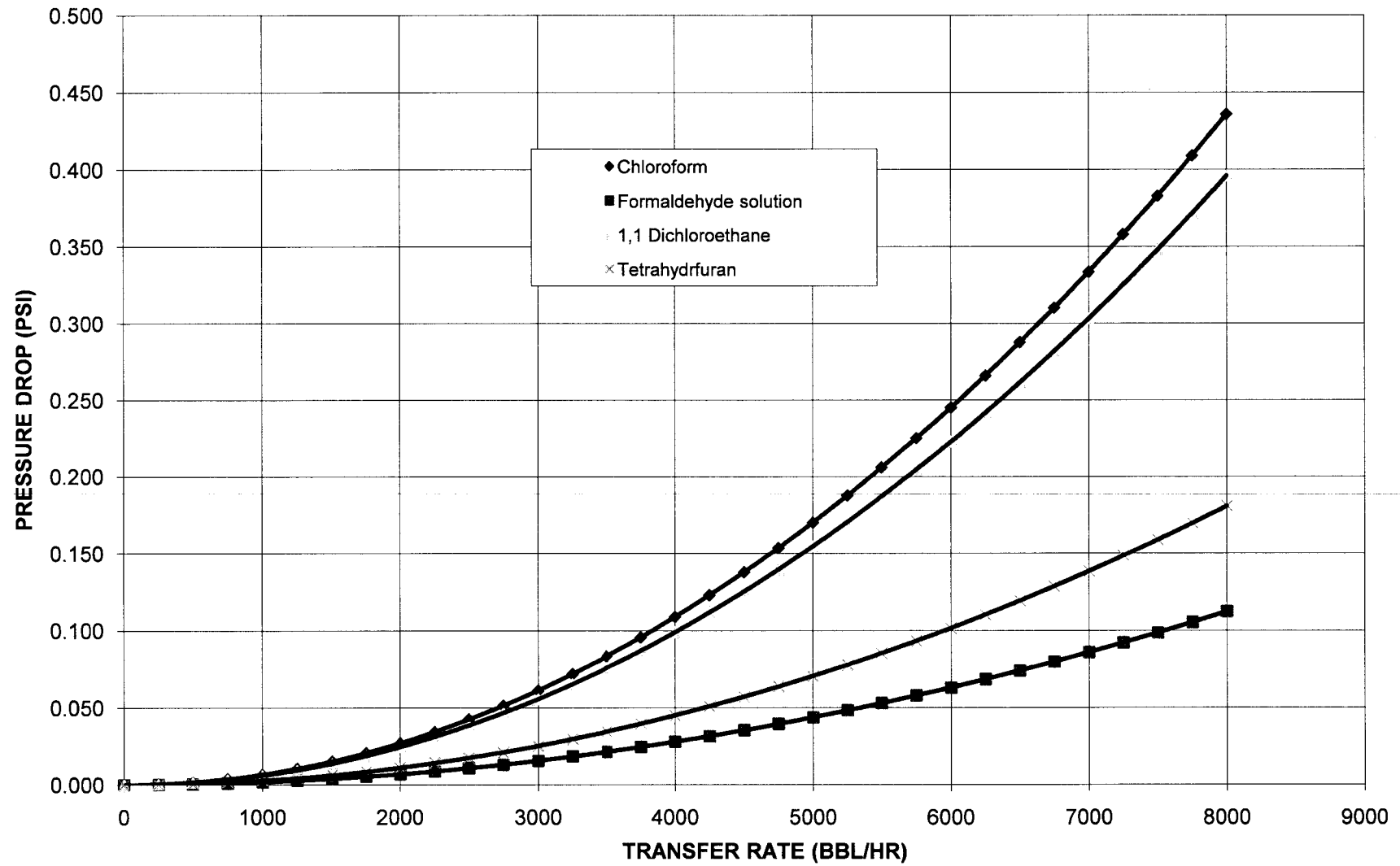


TABLE 4 (SUBCHAPTER "O" CARGOES)

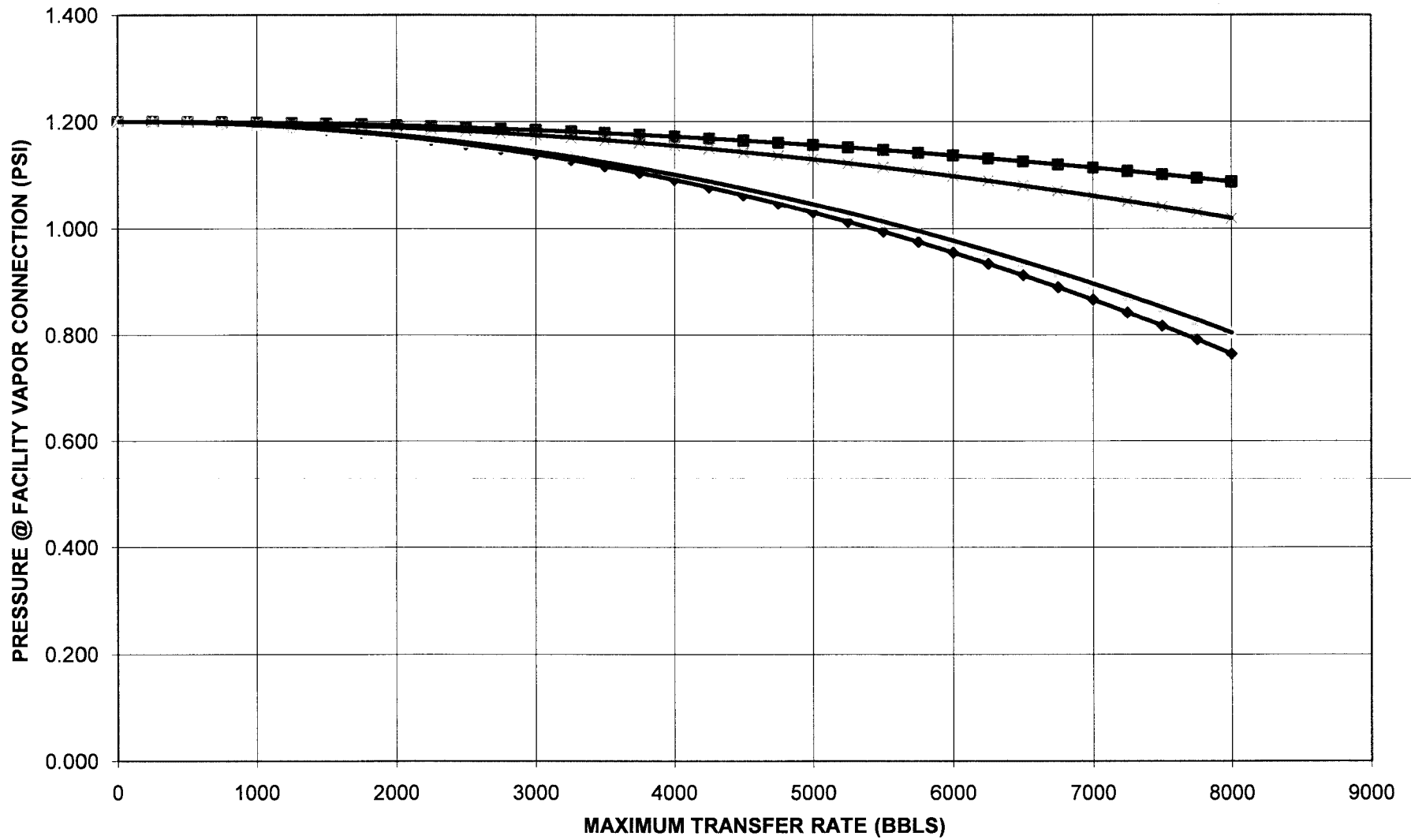
| CHRIS<br>CODE | NAME                                                    | VCS<br>CAT | LIQ<br>SG | VAPOR<br>PRESS | VAPOR<br>SG | VAPOR<br>AIR<br>WEIGHT<br>DENSITY | VAPOR<br>GROWTH<br>RATE | PRESSURE<br>DROP TO PV<br>VALVE IN<br>VCS(psig)<br>(LOADING) | VAPOR<br>VOLUMETRIC<br>FLOW RATE<br>(bbl/h) | AIR<br>EQUIVALENT<br>VOLUMETRIC<br>FLOW RATE | PRESSURE<br>DROP TO<br>SHORE<br>CONNECTION<br>IN VCS (psig)<br>(LOADING)* | PRESSURE<br>DROP TO PV<br>VALVE IN<br>VCS(psig)<br>(UNLOADING) | PRESSURE<br>DROP TO<br>SHORE<br>CONNECTION<br>IN VCS (psig)<br>(UNLOADING)* |
|---------------|---------------------------------------------------------|------------|-----------|----------------|-------------|-----------------------------------|-------------------------|--------------------------------------------------------------|---------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------|-----------------------------------------------------------------------------|
| 1 ACN         | Acrylonitrile                                           | 4          | 0.81      | 5.00           | 1.80        | 0.095                             | 1.1000                  | 0.027                                                        | 3850                                        | 4298                                         | 0.032                                                                     | 0.001                                                          | 0.002                                                                       |
| 2 ADN         | Adiponitrile                                            | 1          | 0.95      | 0.01           | 3.73        | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3503                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 3 ATN         | Acetonitrile                                            | 3          | 0.78      | 0.03           | 1.41        | 0.076                             | 1.0006                  | 0.018                                                        | 3502                                        | 3502                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 4 BAD         | Iso-Butyraldehyde                                       | 1          | 0.80      | 7.80           | 2.50        | 0.131                             | 1.1560                  | 0.041                                                        | 4046                                        | 5308                                         | 0.049                                                                     | 0.002                                                          | 0.003                                                                       |
| 5 BAR         | Butyl acrylate (iso-, n-)                               | 2          | 0.90      | 0.60           | 4.42        | 0.086                             | 1.0120                  | 0.021                                                        | 3542                                        | 3759                                         | 0.025                                                                     | 0.001                                                          | 0.001                                                                       |
| 6 BMH         | Butyl Methacrylate                                      | 2          | 0.88      | 0.29           | 4.9         | 0.081                             | 1.0058                  | 0.019                                                        | 3520                                        | 3640                                         | 0.023                                                                     | 0.001                                                          | 0.001                                                                       |
| 7 BNZ         | Benzene                                                 | 1          | 0.88      | 4.50           | 2.80        | 0.114                             | 1.0900                  | 0.032                                                        | 3815                                        | 4671                                         | 0.038                                                                     | 0.002                                                          | 0.002                                                                       |
| 8 BTR         | n-Butyraldehyde                                         | 1          | 0.80      | 7.80           | 2.50        | 0.131                             | 1.1560                  | 0.041                                                        | 4046                                        | 5308                                         | 0.049                                                                     | 0.002                                                          | 0.003                                                                       |
| 9 BTX         | Benzene, Toluene, Xylene mixtures (10% Benzene or more) | 1          | 0.84      | 7.30           | 2.80        | 0.138                             | 1.1460                  | 0.043                                                        | 4011                                        | 5396                                         | 0.051                                                                     | 0.002                                                          | 0.003                                                                       |
| 10 CCH        | Cyclohexanone                                           | 1          | 0.95      | 0.20           | 3.40        | 0.078                             | 1.0040                  | 0.019                                                        | 3514                                        | 3565                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 11 CHA        | Cyclohexylamine                                         | 1          | 0.87      | 0.62           | 3.42        | 0.083                             | 1.0124                  | 0.020                                                        | 3543                                        | 3703                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 12 CRB        | Chlorobenzene                                           | 1          | 1.11      | 0.80           | 3.88        | 0.087                             | 1.0160                  | 0.021                                                        | 3556                                        | 3799                                         | 0.025                                                                     | 0.001                                                          | 0.001                                                                       |
| 13 CRF        | Chloroform                                              | 3          | 1.48      | 9              | 4.25        | 0.213                             | 1.1800                  | 0.070                                                        | 4130                                        | 6916                                         | 0.083                                                                     | 0.004                                                          | 0.004                                                                       |
| 14 NCT        | Coal Tar Naptha Solvent                                 | 1          | 0.86      | 0.2            | 4           | 0.079                             | 1.0040                  | 0.019                                                        | 3514                                        | 3577                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 15 CRS        | Cresols                                                 | 1          | 1.05      | 0.06           | 3.72        | 0.077                             | 1.0012                  | 0.018                                                        | 3504                                        | 3521                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 16 CTA        | Crotonaldehyde                                          | 4          | 0.85      | 2              | 2.41        | 0.089                             | 1.0400                  | 0.023                                                        | 3640                                        | 3943                                         | 0.027                                                                     | 0.001                                                          | 0.001                                                                       |
| 17 DCH        | 1,1-Dichloroethane                                      | 1          | 1.18      | 9.90           | 3.41        | 0.188                             | 1.1980                  | 0.064                                                        | 4193                                        | 6592                                         | 0.076                                                                     | 0.003                                                          | 0.004                                                                       |
| 18 DPP        | 1,2-Dichloropropane                                     | 3          | 1.16      | 2.5            | 3.89        | 0.110                             | 1.0500                  | 0.029                                                        | 3675                                        | 4418                                         | 0.034                                                                     | 0.001                                                          | 0.002                                                                       |
| 19 DPU        | 1,3-Dichloropropene                                     | 4          | 1.23      | 5.5            | 3.84        | 0.149                             | 1.1100                  | 0.043                                                        | 3885                                        | 5443                                         | 0.052                                                                     | 0.002                                                          | 0.003                                                                       |
| 20 DEN        | Diethylamine                                            | 3          | 0.71      | 1.00           | 2.50        | 0.083                             | 1.0200                  | 0.020                                                        | 3570                                        | 3731                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 21 DIP        | Diisopropanolamine                                      | 1          | 0.98      | 0.01           | 4.59        | 0.076                             | 1.0002                  | 0.018                                                        | 3501                                        | 3504                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 22 DMF        | Dimethylformamide                                       | 1          | 0.95      | 0.30           | 2.51        | 0.078                             | 1.0060                  | 0.019                                                        | 3521                                        | 3569                                         | 0.022                                                                     | 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                  | 0.048                                                        | 3941                                        | 5747                                         | 0.058                                                                     | 0.003                                                          | 0.003                                                                       |
| 24 EAC        | Ethyl acrylate                                          | 2          | 0.93      | 2.00           | 3.50        | 0.099                             | 1.0400                  | 0.025                                                        | 3640                                        | 4183                                         | 0.030                                                                     | 0.001                                                          | 0.002                                                                       |
| 25 EAI        | 2-Ethylhexyl acrylate                                   | 2          | 0.89      | 0.02           | 6.35        | 0.076                             | 1.0004                  | 0.018                                                        | 3501                                        | 3512                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 26 EDC        | Ethylene dichloride                                     | 1          | 1.26      | 4.00           | 3.42        | 0.121                             | 1.0800                  | 0.033                                                        | 3780                                        | 4776                                         | 0.040                                                                     | 0.002                                                          | 0.002                                                                       |
| 27 ETM        | Ethyl Methacrylate                                      | 2          | 0.92      | 1              | 3.94        | 0.090                             | 1.0200                  | 0.022                                                        | 3570                                        | 3879                                         | 0.026                                                                     | 0.001                                                          | 0.001                                                                       |
| 28 EPA        | 2-Ethyl-3-propylacrolein                                | 1          | 0.85      | 0.12           | 4.5         | 0.078                             | 1.0024                  | 0.018                                                        | 3508                                        | 3553                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 29 FFA        | Furfural                                                | 1          | 1.20      | 0.15           | 3.31        | 0.078                             | 1.0030                  | 0.018                                                        | 3511                                        | 3547                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 30 FMS        | Formaldehyde solution (37% to 50%)                      | 1          | 1.13      | 0.15           | 1.03        | 0.076                             | 1.0030                  | 0.018                                                        | 3511                                        | 3510                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 31 MSO        | Mesityl Oxide                                           | 1          | 0.86      | 0.67           | 3.5         | 0.084                             | 1.0134                  | 0.020                                                        | 3547                                        | 3725                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 32 MAM        | Methyl acrylate                                         | 2          | 0.95      | 4.10           | 3.00        | 0.114                             | 1.0820                  | 0.032                                                        | 3787                                        | 4646                                         | 0.038                                                                     | 0.002                                                          | 0.002                                                                       |
| 33 MBE        | Methylcyclopentadiene dimer                             | 1          | 0.74      | 0.04           | 3.10        | 0.076                             | 1.0008                  | 0.018                                                        | 3503                                        | 3511                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |
| 34 MMM        | Methyl methacrylate                                     | 2          | 0.94      | 2.02           | 3.45        | 0.099                             | 1.0404                  | 0.025                                                        | 3641                                        | 4159                                         | 0.030                                                                     | 0.001                                                          | 0.002                                                                       |
| 35 MPL        | Morpholine                                              | 1          | 1.00      | 0.80           | 3.00        | 0.083                             | 1.0160                  | 0.020                                                        | 3556                                        | 3726                                         | 0.024                                                                     | 0.001                                                          | 0.001                                                                       |
| 36 NPM        | 1- or 2-Nitropropane                                    | 1          | 0.99      | 1.05           | 3.06        | 0.086                             | 1.0210                  | 0.021                                                        | 3574                                        | 3804                                         | 0.025                                                                     | 0.001                                                          | 0.001                                                                       |
| 37 PRD        | Pyridine                                                | 1          | 0.98      | 1.30           | 2.72        | 0.086                             | 1.0260                  | 0.021                                                        | 3591                                        | 3830                                         | 0.026                                                                     | 0.001                                                          | 0.001                                                                       |
| 38 STY        | Styrene                                                 | 2          | 0.92      | 0.40           | 3.60        | 0.081                             | 1.0080                  | 0.019                                                        | 3528                                        | 3638                                         | 0.023                                                                     | 0.001                                                          | 0.001                                                                       |
| 39 TCN        | 1,2,3-Trichloropropane                                  | 3          | 1.39      | 0.15           | 5.60        | 0.079                             | 1.0030                  | 0.019                                                        | 3511                                        | 3583                                         | 0.022                                                                     | 0.001                                                          | 0.001                                                                       |
| 40 TEN        | Triethylamine                                           | 3          | 0.73      | 2.50           | 3.49        | 0.105                             | 1.0500                  | 0.027                                                        | 3675                                        | 4323                                         | 0.033                                                                     | 0.001                                                          | 0.002                                                                       |
| 41 THF        | Tetrahydrofuran                                         | 1          | 0.89      | 8.50           | 1.35        | 0.090                             | 1.1700                  | 0.029                                                        | 4095                                        | 4454                                         | 0.035                                                                     | 0.002                                                          | 0.002                                                                       |
| 42 VAM        | Vinyl acetate                                           | 2          | 0.94      | 5.80           | 2.97        | 0.130                             | 1.1160                  | 0.038                                                        | 3906                                        | 5099                                         | 0.045                                                                     | 0.002                                                          | 0.002                                                                       |
|               |                                                         | Max.       | 1.39      | 12.5           | 8.40        | 0.213                             | 1.198                   | 0.070                                                        | 4193                                        | 6916                                         | 0.083                                                                     | 0.004                                                          | 0.004                                                                       |
|               |                                                         | Min.       | 0.63      | 0.01           | 1.03        | 0.076                             | 1.000                   | 0.018                                                        | 3501                                        | 3502                                         | 0.021                                                                     | 0.001                                                          | 0.001                                                                       |

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

## LIQUID TRANSFER RATE vs PRESSURE DROP



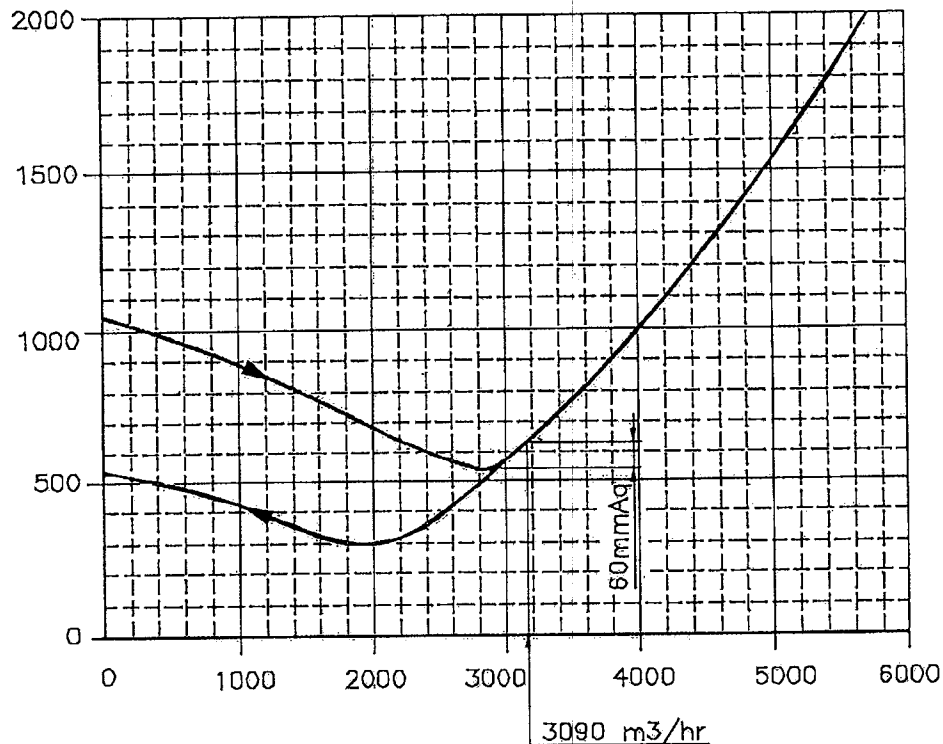
# **PRESSURE vs MAXIMUM TRANSFER RATE (FOR SUB-CHAPTER "O" CARGOES)**



# 

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

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



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

| APPLICABLE STANDARD                   | TEST CONDITION                                                                                      | SHEET NO. 1/1 |
|---------------------------------------|-----------------------------------------------------------------------------------------------------|---------------|
| IMO MSC/Circ.677<br>API Standard 2000 | FLOW TEST PERFORMED ON EQUIPMENT USING AIR,<br>AT TEMP.T=15.6°C AND AMBIENT PRESSURE P=1.0832Kg/cm² |               |

NEW ISO-HV-series flow capacity curve

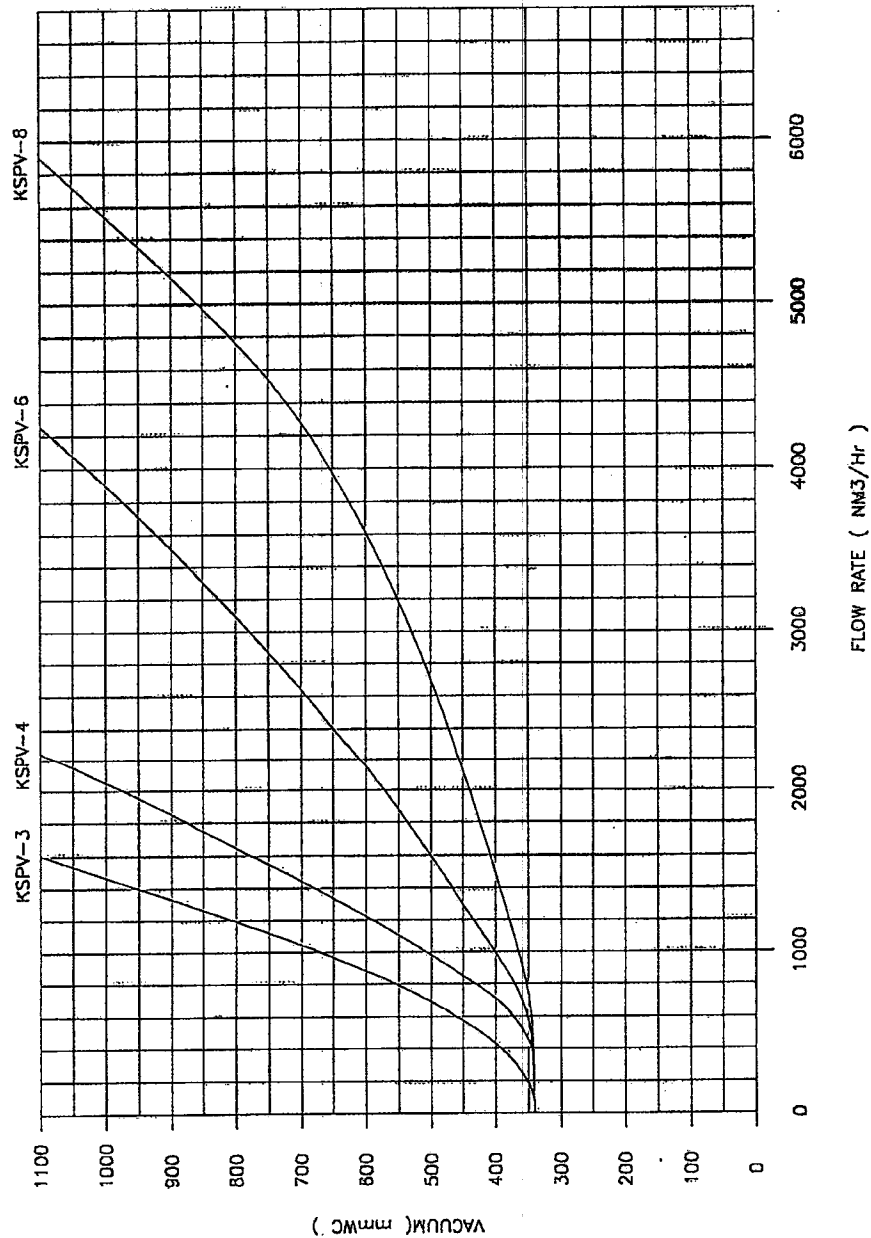
FILEPOSTION : PC02/10/11/flow.doc

TRANKTECH

11

# FLOW CAPACITY CURVE GRAPH

FLOW TEST PERFORMED ON EQUIPMENT  
USING AIR, AT TEMP.  $T=15.6^{\circ}\text{C}$  AND  
AMBIENT PRESSURE  $P=1.0332 \text{ KG/CM}^2$ .



**TANKTECH**

TITLE HIGH VELOCITY VACUUM RELIEF VALVE  
-----  
KSPV TYPE

THE MAXIMUM LIQUID TRANSFER RATE AS IMPOSED BY  
SET POINT OF THE OVERFILL ALARM (46 CFR 39.26-9)

PARAGS: CBC 1700 THRU CBC1709

A CARGO TANK #1.

$$\text{LENGTH OF TRUNK} = 46' - 7\frac{13}{16}"$$

$$\text{WIDTH OF TANK} = 47' - 0"$$

$$\text{SET POINT} = 9" \text{ BELOW THE TRUNK DECK}$$

$$\begin{aligned}\text{VAPOR SPACE VOLUME} &= \frac{46.651 \times 47 \times 9 \times 7.4805}{12 \times 42} \\ &= 292.888 \text{ BBL S.}\end{aligned}$$

$$\text{LOADING RATE} = 3500 \text{ BBL/HR}$$

$$\begin{aligned}\therefore \text{TIME TO STOP THE PUMP BEFORE TANK} \\ \text{OVERFLOW} &= \frac{292.888}{3500} \times 60 = 5.02 \text{ MIN.}\end{aligned}$$

B CARGO TANK # 2 OR 2 S.

$$\text{LENGTH OF TRUNK} = 60' - 0"$$

$$\text{WIDTH OF TANK} = 23' - 6"$$

$$\text{SET POINT} = 9" \text{ BELOW THE TRUNK DECK}$$

$$\begin{aligned}\therefore \text{VAPOR SPACE VOLUME} &= \frac{60 \times 23.5 \times 9 \times 7.4805}{12 \times 42} \\ &= 188.348 \text{ BBL S.}\end{aligned}$$

$$\begin{aligned}\therefore \text{TIME TO STOP THE PUMP BEFORE TANK} \\ \text{OVERFLOW} &= \frac{188.348}{3500} \times 60 = 3.228 \text{ MIN.}\end{aligned}$$

C. CARGO TANK # 3

$$\text{LENGTH OF TRUNK} = 53' - 8"$$

$$\text{WIDTH OF TRUNK} = 47' - 0"$$

$$\text{SET POINT} = 9" \text{ BELOW THE TRUNK DECK.}$$

$$\begin{aligned}\therefore \text{VAPOR SPACE VOLUME} &= \frac{53.667 \times 47 \times 9 \times 7.4805}{12 \times 42} \\ &= 336.936 \text{ BBL S.}\end{aligned}$$

$$\begin{aligned}\therefore \text{TIME TO STOP THE PUMP BEFORE TANK} \\ \text{OVERFLOW} &= \frac{336.936}{3500} \times 60 = 5.776 \text{ MIN.}\end{aligned}$$

(18)