| REVISIONS | | | |
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## CONRAD SHIPYARD

## 297'-6" x 54' x 12' INLAND TANK BARGE

# VAPOR CONTROL SYSTEM CALCULATIONS

| | | | | |
|---|---|---|---|---|
| SCALE: | NONE | DATE: | 11/19/2012 | DWG. NO. |
| DRAWN BY: | R. ALLUMS | CK'D BY: | R. ALLUMS | C-32 |
| HULL NO. | C1007, C1008 | JOB NO. | 12-085 | REV. 0 |

## I. VAPOR CONTROL SYSTEM CALCULATIONS - SUMMARY

### A. General Description of Vessel:

| | | |
|---|---|---|
| Builder: | CONRAD SHIPYARD | |
| Builder's hull numbers: | C1007, C1008 | |
| Year Built: | 2013 | |
| Official Numbers: | 1243651, 1243652 | |
| Owner: | Canal Barge | |
| Vessel Names: | CBC 374, CBC 375 | |
| Vessel Dimensions: | 297'-6" x 54'-0" x 12'-0" | |
| Service: | Inland Tank Barge (D/O) | |
| Classification: | None | |
| Max Design Working Pressure of Tanks: | 3.00 | (psig) |
| Max Cargo Loading Rate | 5,500 | (bbl/hr) |
| Maximum Discharge Rate | 4,300 | (bbl/hr) |
| VCS Cargoes: | See Table 1 | |
| Maximum Vapor-Air Mixture Density: | 0.35 (Pentane, all isomers) | (lbm/ft^3) |
| Maximum Vapor Growth Rate: | 1.54 (Pentane, all isomers) | (lbm/ft^3) |

### B. General Description of Vapor Control System:

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

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

2. **High Velocity PV Valve:**

| | | |
|---|---|---|
| Model: | ERL 6" SUPERAC PV-6 | |
| Pressure Setting: | 1.50 | (psig) |
| Vacuum Setting: | 0.5 | (psig) |
| PV Valve Flow Capacity: | See Att. 1 | (bbl/hr) |

3. **Spill Valve:**

| | | |
|---|---|---|
| Model: | None installed | |
| Pressure Setting: | N/A | |

4. **Vapor Recovery Hose:**

| | | |
|---|---|---|
| Diameter: | 8" (assumed) | |
| Length: | 50' (assumed) | |

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

| | | |
|---|---|---|
| Model: | See #2 above. | |
| Pressure Setting: | 1.50 | (psig) |
| Vacuum Setting: | 0.5 | (psig) |

## C. VCS Calculations:

1. **Cargo Authority:**
   The vapor collection system installed on this barge is designed for Grade A and lower petroleum products and Type II/III chemicals. Typical cargoes to be carried by this barge are listed in Table 1. These cargoes are to be listed in the Cargo Authority Attachment (CAA) of the barge's Certificate of Inspection. Note that Table 1 is not intended to be an all-inclusive list and the CAA should therefore not be limited to these cargoes. Other cargoes with less restrictive or equal characteristics shall also be included on the CAA. VCS Categories 1 through 7 are requested.

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

3. **The Maximum Liquid Transfer Rate as Imposed by the Capacity of the Cargo Tank Venting System: (Ref: 46 CFR 39.20-11)**
   Tanks #1 P/S are the farthest tanks from the High-Velocity P-V Valve in terms of total equivalent pipe length. Using factors from Reference 4 and 9, the total equivalent length of pipe is calculated for this path. This calculation is shown in Table 2.

   Using Darcy's equation, and friction factors selected as appropriate for the pipe size, and the maximum liquid transfer rate, the pressure drop along the VCS piping from tank #1P to the P-V Valve is calculated using the total equivalent length of pipe from Table 2. The pressure drop calculations were done for the maximum loading rate (5,500 BBL/hr) for this barge. This maximum loading rate is based on loading one tank at a time. This calculation is shown in Table 3.

   Conclusions:
   Using a 5,500 bbl/hr maximum liquid transfer rate (for Pentane and lower cargos), the vapor-air mixture and air-equivalent volumetric flow rates for each cargo are shown in Table 3. The greatest pressure drop in the cargo tank venting system is 0.25 psig for Pentane cargo. At a pressure relief setting of 1.5 psig, the high-velocity P-V valve has an adequate flow capacity (see attachment 1). The greatest total back pressure imposed on the tanks by the cargo tank venting system (2.89 psig) does not exceeed the design working pressure of the cargo tanks (3.00 psig). Also, the vacuum relieving capacity of the P-V Valve has been checked against the maximum discharge rate and has been found to have adequate vacuum relieving capacity (see Table 3).

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

5. **The Maximum Liquid Transfer Rate as Imposed by the Set Point of the Overfill Alarm:**
   At the maximum cargo loading rate of 5,500 bbl/hr, required overfill alarm set points have been calculated such that the person in charge of the transfer operations has more than 60 seconds from the overfill alarm to stop the transfer operations before the tank overflows. (See attached overfill alarm set point calculation sheets.) The overfill alarms will need to be set at or below these calculated levels to ensure that the VCS complies with 46 CFR 39.20-9. In addition, the overfill alarms must also be set at or below a capacity of 98.5% to comply with 33CFR155.775.

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

   Using Darcy's equation, and friction factors selected as appropriate for the pipe size, and the maximum liquid transfer rate, the pressure drop along the VCS piping from tank #1P to the facility vapor connection is calculated using the total equivalent length of pipe from Table 4. These calculations are shown in Table 5.

   Conclusions:
   Pressure drop at the maximum liquid transfer rate of 5,500 bbl/hr (for Pentane and lower cargoes) along this path for each cargo is given in Table 5. The highest pressure drop (for Pentane) does not exceed 80 percent of the P-V valve pressure setting. If the pressure drop between the facility vapor connection and the shore facility's pressure sensor is known, it should be added to the pressure drop along this path to ensure that the total pressure drop does not exceed 80 percent of the P-V valve pressure setting.

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

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

| | CHRIS Code | Name | Type | VCS Category | Liquid S.G. | *Vapor Press. @ 115 F (psia) | Vapor S.G. | Vapor-air Mixture Weight Density (lb/ft^3) | Vapor Growth Rate | Max. Loading Rate | Vapor Volumetric Flow Rate (bbl/hr) | Air Equivalent Volumetric Flow Rate (bbl/hr) | Pressure Drop to PV Valve in VCS (See Table 3) (psig) | Pressure Drop to Facility Connection in VCS (See Table 5) (psig) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ACN | Acrylonitrile | III | 4 | 0.81 | 5.00 | 1.80 | 0.095 | 1.10 | 5,500 | 6050 | 6756 | 0.034 | 0.079 |
| 2 | ACT | Acetone | D | 1 | 0.79 | 10.00 | 2.00 | 0.123 | 1.20 | 5,500 | 6600 | 8393 | 0.053 | 0.121 |
| 3 | ACP | Acetophenone | D | 1 | 1.03 | 0.60 | 4.14 | 0.085 | 1.01 | 5,500 | 5566 | 5881 | 0.026 | 0.060 |
| 4 | AND | Adiponitrile | II | 1 | 0.95 | 0.01 | 3.73 | 0.076 | 1.00 | 5,500 | 5501 | 5506 | 0.023 | 0.052 |
| 5 | AEC | Amyl acetate (all isomers) | D | 1 | 0.88 | 0.33 | 0.10 | 0.075 | 1.01 | 5,500 | 5536 | 5485 | 0.023 | 0.052 |
| 6 | AAI | Amyl Alcohol (iso-, n-, sec-, primary) | D | 1 | 0.82 | 0.30 | 3.04 | 0.079 | 1.01 | 5,500 | 5533 | 5637 | 0.024 | 0.055 |
| 7 | ATN | Acetonitrile | III | 3 | 0.78 | 0.03 | 1.41 | 0.076 | 1.00 | 5,500 | 5503 | 5505 | 0.023 | 0.052 |
| 8 | BAL | Benzyl Alcohol | D | 1 | 1.05 | 0.10 | 3.73 | 0.077 | 1.00 | 5,500 | 5511 | 5557 | 0.023 | 0.053 |
| 9 | BNZ | Benzene | III | 1 | 0.88 | 4.50 | 2.80 | 0.114 | 1.25 | 5,500 | 6875 | 8420 | 0.054 | 0.122 |
| 10 | BTX | Benzene, Toluene, Xylene mixtures (10% Benzene or more) | III | 1 | 0.84 | 7.30 | 2.80 | 0.138 | 1.25 | 5,500 | 6875 | 9252 | 0.065 | 0.147 |
| 11 | BAR | Butyl Acrylate (iso-, n-) | III | 2 | 0.90 | 0.60 | 4.42 | 0.086 | 1.01 | 5,500 | 5566 | 5908 | 0.026 | 0.060 |
| 12 | BAX | Butyl Acetate (all isomers) | D | 1 | 0.87 | 0.60 | 4.00 | 0.085 | 1.01 | 5,500 | 5566 | 5867 | 0.026 | 0.059 |
| 13 | IAL | Butyl Alcohol (iso-) | D | 1 | 0.81 | 0.90 | 2.60 | 0.083 | 1.02 | 5,500 | 5599 | 5843 | 0.026 | 0.059 |
| 14 | BAN | Butyl Alcohol (n-) | D | 1 | 0.81 | 0.50 | 0.10 | 0.074 | 1.01 | 5,500 | 5555 | 5477 | 0.023 | 0.052 |
| 15 | BAS | Butyl Alcohol (sec-) | D | 1 | 0.81 | 1.30 | 2.60 | 0.086 | 1.03 | 5,500 | 5643 | 5994 | 0.027 | 0.062 |
| 16 | BAT | Butyl Alcohol (tert-) | D | 1 | 0.78 | 2.80 | 2.60 | 0.097 | 1.06 | 5,500 | 5808 | 6562 | 0.032 | 0.074 |
| 17 | BPH | Butyl Benzyl Phthalate | D | 1 | 1.12 | 0.01 | 10.80 | 0.077 | 1.00 | 5,500 | 5501 | 5518 | 0.023 | 0.052 |
| 18 | BAD | iso-Butyraldehyde | III | 1 | 0.80 | 7.80 | 2.50 | 0.131 | 1.16 | 5,500 | 6358 | 8344 | 0.053 | 0.120 |
| 19 | BTR | n-Butyraldehyde | III | 1 | 0.80 | 7.80 | 2.50 | 0.131 | 1.16 | 5,500 | 6358 | 8344 | 0.053 | 0.120 |
| 20 | BUE | Butyl Toluene | D | 1 | 0.85 | 0.10 | 5.11 | 0.078 | 1.00 | 5,500 | 5511 | 5580 | 0.024 | 0.054 |
| 21 | CLS | Caprolactam Solutions | D | 1 | 1.02 | 0.05 | 3.90 | 0.077 | 1.00 | 5,500 | 5506 | 5530 | 0.023 | 0.053 |
| 22 | CCH | Cyclohexanone (Anolone) | III | 1 | 0.95 | 0.20 | 3.40 | 0.078 | 1.00 | 5,500 | 5522 | 5603 | 0.024 | 0.054 |
| 23 | CHA | Cyclohexylamine | III | 1 | 0.87 | 0.62 | 3.42 | 0.083 | 1.01 | 5,500 | 5568 | 5820 | 0.026 | 0.058 |
| 24 | CHX | Cyclohexane | D | 1 | 0.78 | 4.50 | 2.90 | 0.116 | 1.09 | 5,500 | 5995 | 7410 | 0.041 | 0.094 |
| 25 | CHN | Cyclohexanol | D | 1 | 0.95 | 0.15 | 3.45 | 0.078 | 1.00 | 5,500 | 5517 | 5579 | 0.023 | 0.054 |
| 26 | CPD | 1,3-Cyclopentadiene dimer (molten) | D | 2 | 0.69 | 0.25 | 4.55 | 0.080 | 1.01 | 5,500 | 5528 | 5677 | 0.024 | 0.055 |
| 27 | CMP | p-Cymene | D | 1 | 0.86 | 0.11 | 4.62 | 0.078 | 1.00 | 5,500 | 5512 | 5579 | 0.023 | 0.054 |
| 28 | CRB | Chlorobenzene | III | 1 | 1.11 | 0.80 | 3.88 | 0.087 | 1.02 | 5,500 | 5588 | 5972 | 0.027 | 0.061 |
| 29 | CRS | Cresols | III | 1 | 1.05 | 0.08 | 3.72 | 0.077 | 1.00 | 5,500 | 5509 | 5546 | 0.023 | 0.053 |
| 30 | CUM | Cumene | D | 1 | 0.86 | 0.60 | 4.20 | 0.085 | 1.01 | 5,500 | 5566 | 5887 | 0.026 | 0.060 |
| 31 | IDA | Decaldehyde (iso-) | D | 1 | 0.83 | 0.01 | 5.00 | 0.076 | 1.00 | 5,500 | 5501 | 5508 | 0.023 | 0.052 |
| 32 | DAL | Decaldehyde (n-) | D | 1 | 0.83 | 0.00 | 5.01 | 0.076 | 1.00 | 5,500 | 5500 | 5500 | 0.023 | 0.052 |
| 33 | DCE | Decene | D | 1 | 0.74 | 0.12 | 4.80 | 0.078 | 1.00 | 5,500 | 5513 | 5590 | 0.024 | 0.054 |
| 34 | DAX | Decyl Alcohol (all isomers) (Decanol) | D | 1 | 0.83 | 0.01 | 5.30 | 0.076 | 1.00 | 5,500 | 5501 | 5508 | 0.023 | 0.052 |
| 35 | DBZ | Decylbenzene (n-) | D | 1 | 0.86 | 0.01 | 7.52 | 0.076 | 1.00 | 5,500 | 5501 | 5512 | 0.023 | 0.052 |
| 36 | DAA | Diacetone Alcohol | D | 1 | 0.97 | 0.10 | 4.00 | 0.078 | 1.00 | 5,500 | 5511 | 5562 | 0.023 | 0.053 |
| 37 | DCH | 1,1-Dicholoroethane | III | 1 | 1.18 | 9.90 | 3.41 | 0.188 | 1.20 | 5,500 | 6589 | 10361 | 0.081 | 0.185 |
| 38 | DPA | Dibutyl Phthalate (ortho-) | D | 1 | 1.05 | 0.00 | 9.59 | 0.076 | 1.00 | 5,500 | 5500 | 5500 | 0.023 | 0.052 |
| 39 | DEB | Diethybenzene | D | 1 | 0.87 | 0.08 | 4.62 | 0.078 | 1.00 | 5,500 | 5509 | 5558 | 0.023 | 0.053 |
| 40 | DEG | Diethylene Glycol | D | 1 | 1.12 | 0.01 | 3.66 | 0.076 | 1.00 | 5,500 | 5501 | 5506 | 0.023 | 0.052 |
| 41 | DEN | Diethylamine | III | 3 | 0.71 | 1.00 | 2.50 | 0.083 | 1.02 | 5,500 | 5610 | 5864 | 0.026 | 0.059 |
| 42 | DBL | Diisobulylene | D | 1 | 0.72 | 2.00 | 3.86 | 0.103 | 1.04 | 5,500 | 5720 | 6654 | 0.033 | 0.076 |
| 43 | DIK | Diisobutyl Ketone | D | 1 | 0.81 | 0.16 | 4.90 | 0.079 | 1.00 | 5,500 | 5518 | 5623 | 0.024 | 0.054 |
| 44 | DIP | Diisopropanolamme | III | 1 | 0.98 | 0.01 | 4.59 | 0.076 | 1.00 | 5,500 | 5501 | 5507 | 0.023 | 0.052 |
| 45 | DIX | Diisopropylbenzene (all isomers) | D | 1 | 0.86 | 0.03 | 5.60 | 0.077 | 1.00 | 5,500 | 5503 | 5527 | 0.023 | 0.053 |
| 46 | DTL | Dimethyl Phthalate | D | 1 | 1.19 | 0.00 | 6.69 | 0.076 | 1.00 | 5,500 | 5500 | 5500 | 0.023 | 0.052 |
| 47 | DOP | Dioclyl Phthalate | D | 1 | 0.98 | 0.00 | 13.47 | 0.076 | 1.00 | 5,500 | 5500 | 5500 | 0.023 | 0.052 |
| 48 | DPN | Dipentene | D | 1 | 0.84 | 0.10 | 4.90 | 0.078 | 1.00 | 5,500 | 5511 | 5577 | 0.023 | 0.054 |
| 49 | DIL | Diphenyl | D | 1 | 0.99 | 0.01 | 5.31 | 0.076 | 1.00 | 5,500 | 5501 | 5508 | 0.023 | 0.052 |
| 50 | DDO | Diphenyl, Diphenyl Ether Mixtures | D | 1 | 1.07 | 0.01 | 5.86 | 0.076 | 1.00 | 5,500 | 5501 | 5509 | 0.023 | 0.052 |
| 51 | DMF | Dimethylformamide | III | 1 | 0.95 | 0.30 | 2.51 | 0.078 | 1.01 | 5,500 | 5533 | 5610 | 0.024 | 0.054 |
| 52 | DPE | Diphenyl Ether | D | 1 | 1.07 | 0.01 | 5.87 | 0.076 | 1.00 | 5,500 | 5501 | 5509 | 0.023 | 0.052 |
| 53 | DPG | Dipropylene Glycol | D | 1 | 1.03 | 0.07 | 4.63 | 0.077 | 1.00 | 5,500 | 5508 | 5551 | 0.023 | 0.053 |
| 54 | DPX | 1,1-, 1,2-, 1,3-Dichloropropane | III | 3 | 1.16 | 6.30 | 3.90 | 0.162 | 1.13 | 5,500 | 6193 | 9034 | 0.062 | 0.140 |
| 55 | DFF | Distillates Flashed Feed Stocks | D | 1 | 0.75 | 2.30 | 3.40 | 0.102 | 1.05 | 5,500 | 5753 | 6661 | 0.033 | 0.076 |
| 56 | DSR | Distillates Straight Run | D | 1 | 0.73 | 2.30 | 3.40 | 0.102 | 1.05 | 5,500 | 5753 | 6661 | 0.033 | 0.076 |
| 57 | DOZ | Dodecene (all isomers) | D | 1 | 0.76 | 0.02 | 5.81 | 0.077 | 1.00 | 5,500 | 5502 | 5519 | 0.023 | 0.052 |
| 58 | DDB | Dodecylbenzene | D | 1 | 0.86 | 4.70 | 8.40 | 0.240 | 1.25 | 5,500 | 6875 | 12196 | 0.112 | 0.256 |
| 59 | EAC | Ethyl Acrylate | III | 2 | 0.93 | 2.00 | 3.50 | 0.100 | 1.04 | 5,500 | 5720 | 6543 | 0.032 | 0.074 |
| 60 | EAI | 2-Ethylhexyl acrylate | III | 2 | 0.89 | 0.02 | 6.35 | 0.077 | 1.00 | 5,500 | 5502 | 5520 | 0.023 | 0.052 |
| 61 | EEA | 2-Ethoxyethyl acetate | D | 1 | 0.97 | 0.02 | 4.70 | 0.077 | 1.00 | 5,500 | 5503 | 5517 | 0.023 | 0.052 |
| 62 | ETG | Ethoxy Triglycol (crude) | D | 1 | 1.02 | 0.00 | 6.14 | 0.076 | 1.00 | 5,500 | 5500 | 5500 | 0.023 | 0.052 |
| 63 | ETA | Ethyl Acetate | D | 1 | 0.90 | 4.50 | 3.04 | 0.119 | 1.09 | 5,500 | 5995 | 7504 | 0.042 | 0.097 |
| 64 | EAA | Ethyl Acetoacetate | D | 1 | 1.03 | 0.20 | 4.48 | 0.079 | 1.00 | 5,500 | 5522 | 5639 | 0.024 | 0.055 |
| 65 | EAL | Ethyl Alcohol (Ethanol) | D | 1 | 0.79 | 3.50 | 1.60 | 0.086 | 1.07 | 5,500 | 5885 | 6255 | 0.030 | 0.067 |
| 66 | ETB | Ethyl Benzene | D | 1 | 0.87 | 0.60 | 3.56 | 0.083 | 1.01 | 5,500 | 5566 | 5824 | 0.026 | 0.058 |
| 67 | EBT | Ethyl Butanol | D | 1 | 0.83 | 0.12 | 3.52 | 0.078 | 1.00 | 5,500 | 5513 | 5564 | 0.023 | 0.053 |
| 68 | EBE | Ethyl tert-butyl ether | D | 1 | 0.74 | 0.19 | 3.50 | 0.078 | 1.00 | 5,500 | 5521 | 5602 | 0.024 | 0.054 |
| 69 | EBR | Ethyl butyrate | D | 1 | 0.88 | 1.00 | 4.00 | 0.090 | 1.02 | 5,500 | 5610 | 6107 | 0.028 | 0.064 |
| 70 | ECY | Ethyl Cyclohexane | D | 1 | 0.79 | 0.50 | 3.87 | 0.083 | 1.01 | 5,500 | 5555 | 5796 | 0.025 | 0.058 |
| 71 | EDC | Ethylene dichloride | III | 1 | 1.26 | 4.00 | 3.42 | 0.122 | 1.08 | 5,500 | 5940 | 7508 | 0.043 | 0.097 |
| 72 | EGL | Ethylene Glycol | III | 1 | 1.19 | 0.01 | 2.21 | 0.076 | 1.00 | 5,500 | 5501 | 5503 | 0.023 | 0.052 |
| 73 | EMA | Ethylene Glycol Butyl Ether Acetate | D | 1 | 0.94 | 0.05 | 5.52 | 0.077 | 1.00 | 5,500 | 5506 | 5544 | 0.023 | 0.053 |
| 74 | EGY | Ethylene Glycol Diacetate | D | 1 | 1.10 | 0.01 | 5.03 | 0.076 | 1.00 | 5,500 | 5501 | 5508 | 0.023 | 0.052 |
| 75 | EPE | Ethylene Glycol Phenyl Ether | D | 1 | 1.10 | 0.01 | 4.80 | 0.076 | 1.00 | 5,500 | 5501 | 5508 | 0.023 | 0.052 |
| 76 | EEP | Ethyl-3-ethoxypropionate | D | 1 | 0.95 | 0.01 | 5.00 | 0.076 | 1.00 | 5,500 | 5501 | 5510 | 0.023 | 0.052 |
| 77 | EHX | 2-Ethylhexanol (Octanol) | D | 1 | 0.84 | 0.02 | 4.50 | 0.076 | 1.00 | 5,500 | 5502 | 5514 | 0.023 | 0.052 |
| 78 | EPR | Ethyl Propionate | D | 1 | 0.89 | 3.50 | 1.60 | 0.086 | 1.07 | 5,500 | 5885 | 6255 | 0.030 | 0.067 |

| | CHRIS Code | Name | Type | VCS Category | Liquid S.G. | *Vapor Press. @ 115 F (psia) | Vapor S.G. | Vapor-air Mixture Weight Density (lb/ft^3) | Vapor Growth Rate | Max. Loading Rate | Vapor Volumetric Flow Rate (bbl/hr) | Air Equivalent Volumetric Flow Rate (bbl/hr) | Pressure Drop to PV Valve in VCS (See Table 3) (psig) | Pressure Drop to Facility Connection in VCS (See Table 5) (psig) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 79 | ETE | Ethyl Toluene | D | 1 | 0.88 | 0.28 | 4.15 | 0.080 | 1.01 | 5,500 | 5531 | 5679 | 0.024 | 0.056 |
| 80 | FAM | Formamide | D | 1 | 1.13 | 0.10 | 1.55 | 0.076 | 1.00 | 5,500 | 5511 | 5520 | 0.023 | 0.052 |
| 81 | FMS | Formaldehyde Solution | III | 1 | 1.13 | 0.15 | 1.03 | 0.076 | 1.00 | 5,500 | 5517 | 5517 | 0.023 | 0.052 |
| 82 | FAL | Furfuryl Alcohol | D | 1 | 1.13 | 0.05 | 3.40 | 0.077 | 1.00 | 5,500 | 5506 | 5526 | 0.023 | 0.053 |
| 83 | FFA | Furfural | III | 1 | 1.20 | 0.15 | 3.31 | 0.078 | 1.00 | 5,500 | 5517 | 5575 | 0.023 | 0.053 |
| 84 | GAK | Gasoline Blending Stocks: Alkylates | D | 1 | 0.75 | 12.50 | 3.40 | 0.217 | 1.25 | 5,500 | 6875 | 11610 | 0.102 | 0.232 |
| 85 | GRF | Gasoline Blending Stocks: Reformates | D | 1 | 0.80 | 12.50 | 3.40 | 0.217 | 1.25 | 5,500 | 6875 | 11610 | 0.102 | 0.232 |
| 86 | GAT | Gasolines: Automotive | D | 1 | 0.74 | 12.50 | 3.40 | 0.217 | 1.25 | 5,500 | 6875 | 11610 | 0.102 | 0.232 |
| 87 | GAV | Gasolines: Aviation | D | 1 | 0.71 | 12.50 | 3.40 | 0.217 | 1.25 | 5,500 | 6875 | 11610 | 0.102 | 0.232 |
| 88 | GCS | Gasolines: Casinghead | D | 1 | 0.67 | 12.50 | 3.40 | 0.217 | 1.25 | 5,500 | 6875 | 11610 | 0.102 | 0.232 |
| 89 | GPL | Gasolines: Polymer | D | 1 | 0.75 | 12.50 | 3.40 | 0.217 | 1.25 | 5,500 | 6875 | 11610 | 0.102 | 0.232 |
| 90 | GSR | Gasolines: StraightRun | D | 1 | 0.75 | 12.50 | 3.40 | 0.217 | 1.25 | 5,500 | 6875 | 11610 | 0.102 | 0.232 |
| 91 | GCR | Glycerine | D | 1 | 1.26 | 0.00 | 3.17 | 0.076 | 1.00 | 5,500 | 5500 | 5500 | 0.023 | 0.052 |
| 92 | HMX | Heptane (all isomers) | D | 1 | 0.68 | 2.50 | 3.45 | 0.105 | 1.05 | 5,500 | 5775 | 6779 | 0.035 | 0.079 |
| 93 | HEP | Heptonic Acid | D | 1 | 0.92 | 0.01 | 4.49 | 0.076 | 1.00 | 5,500 | 5501 | 5507 | 0.023 | 0.052 |
| 94 | HTX | Heptanol (all isomers) | D | 1 | 0.82 | 0.04 | 4.00 | 0.077 | 1.00 | 5,500 | 5504 | 5525 | 0.023 | 0.053 |
| 95 | HPX | Heptene (all isomers) | D | 2 | 0.70 | 2.90 | 3.40 | 0.109 | 1.06 | 5,500 | 5819 | 6958 | 0.037 | 0.083 |
| 96 | HXS | Hexane (all isomers) | D | 1 | 0.66 | 7.00 | 3.00 | 0.142 | 1.14 | 5,500 | 6270 | 8561 | 0.055 | 0.126 |
| 97 | HXO | Hexaonic Acid | D | 1 | 0.93 | 0.01 | 4.00 | 0.076 | 1.00 | 5,500 | 5501 | 5506 | 0.023 | 0.052 |
| 98 | HXN | Hexanol | D | 1 | 0.82 | 1.00 | 3.52 | 0.088 | 1.02 | 5,500 | 5610 | 6031 | 0.027 | 0.063 |
| 99 | HEX | Hexene (all isomers) | D | 2 | 0.67 | 8.00 | 2.90 | 0.148 | 1.16 | 5,500 | 6380 | 8882 | 0.060 | 0.136 |
| 100 | HXG | Hexylene Glycol | D | 1 | 0.92 | 0.01 | 1.10 | 0.076 | 1.00 | 5,500 | 5501 | 5501 | 0.023 | 0.052 |
| 101 | IPH | Isophorone | D | 1 | 0.93 | 0.01 | 4.75 | 0.076 | 1.00 | 5,500 | 5501 | 5507 | 0.023 | 0.052 |
| 102 | JPF | Jet Fuels: JP-4 | D | 1 | 0.81 | 3.40 | 4.00 | 0.124 | 1.07 | 5,500 | 5874 | 7499 | 0.042 | 0.097 |
| 103 | JPV | Jet Fuels JP-5 (Kerosene, heavy) | D | 1 | 0.82 | 0.10 | 4.00 | 0.078 | 1.00 | 5,500 | 5511 | 5562 | 0.023 | 0.053 |
| 104 | KRS | Kerosene | D | 1 | 0.81 | 0.15 | 4.50 | 0.079 | 1.00 | 5,500 | 5517 | 5605 | 0.024 | 0.054 |
| 105 | MTT | Methyl Acetate | D | 1 | 0.92 | 6.10 | 2.60 | 0.122 | 1.12 | 5,500 | 6171 | 7812 | 0.046 | 0.105 |
| 106 | MAL | Methyl Alcohol (Methanol) | D | 1 | 0.79 | 6.63 | 1.10 | 0.079 | 1.13 | 5,500 | 6229 | 6355 | 0.030 | 0.070 |
| 107 | MAC | Methylamyl Acetate | D | 1 | 0.86 | 0.33 | 4.97 | 0.082 | 1.01 | 5,500 | 5536 | 5756 | 0.025 | 0.057 |
| 108 | MAA | Methylamyl Alcohol | D | 1 | 0.81 | 0.43 | 3.52 | 0.081 | 1.01 | 5,500 | 5547 | 5730 | 0.025 | 0.057 |
| 109 | MAK | Methylamyl Keytone | D | 1 | 0.82 | 0.05 | 1.00 | 0.076 | 1.00 | 5,500 | 5506 | 5506 | 0.023 | 0.052 |
| 110 | MAM | Methyl Acrylate | III | 2 | 0.95 | 4.10 | 3.00 | 0.115 | 1.08 | 5,500 | 5951 | 7303 | 0.040 | 0.092 |
| 111 | MBE | Methyl Tert-Butyl Ether (MTBE) | D | 1 | 0.74 | 0.04 | 3.10 | 0.077 | 1.00 | 5,500 | 5504 | 5519 | 0.023 | 0.052 |
| 112 | MBK | Methyl Butyl Ketone | D | 1 | 0.81 | 0.97 | 3.50 | 0.088 | 1.02 | 5,500 | 5607 | 6012 | 0.027 | 0.062 |
| 113 | MBU | Methyl Butyrate | D | 1 | 0.90 | 1.26 | 3.53 | 0.091 | 1.03 | 5,500 | 5639 | 6168 | 0.029 | 0.065 |
| 114 | MEK | Methyl Ethyl Ketone | D | 1 | 0.80 | 4.50 | 2.50 | 0.108 | 1.09 | 5,500 | 5995 | 7135 | 0.038 | 0.088 |
| 115 | MHK | Methyl Heptyl Ketone | D | 1 | 0.83 | 0.06 | 4.90 | 0.077 | 1.00 | 5,500 | 5507 | 5546 | 0.023 | 0.053 |
| 116 | MIK | Methyl Isobutyl Ketone | D | 1 | 0.80 | 1.15 | 3.45 | 0.089 | 1.02 | 5,500 | 5627 | 6096 | 0.028 | 0.064 |
| 117 | MMM | Methyl methacrylate | III | 2 | 0.94 | 2.02 | 3.45 | 0.099 | 1.04 | 5,500 | 5722 | 6538 | 0.032 | 0.074 |
| 118 | MNA | Methyl Naphthalene | D | 1 | 1.02 | 0.01 | 4.91 | 0.076 | 1.00 | 5,500 | 5501 | 5508 | 0.023 | 0.052 |
| 119 | MNS | Mineral Spirits | D | 1 | 0.75 | 0.20 | 4.30 | 0.079 | 1.00 | 5,500 | 5522 | 5633 | 0.024 | 0.055 |
| 120 | MPL | Morpholine | III | 1 | 1.00 | 0.80 | 3.00 | 0.084 | 1.02 | 5,500 | 5588 | 5857 | 0.026 | 0.059 |
| 121 | MRE | Myrcene | D | 1 | 0.80 | 0.17 | 4.70 | 0.079 | 1.00 | 5,500 | 5519 | 5625 | 0.024 | 0.054 |
| 122 | PTN | Naphtha: Petroleum | D | 1 | 0.74 | 0.19 | 3.50 | 0.078 | 1.00 | 5,500 | 5521 | 5600 | 0.024 | 0.054 |
| 123 | NSV | Naphtha: Solvent | D | 1 | 0.87 | 0.20 | 3.50 | 0.078 | 1.00 | 5,500 | 5522 | 5607 | 0.024 | 0.054 |
| 124 | NSS | Naphtha: Stoddard Solvent | D | 1 | 0.78 | 0.20 | 4.30 | 0.079 | 1.00 | 5,500 | 5522 | 5633 | 0.024 | 0.055 |
| 125 | NVM | Naphtha: VM&P | D | 1 | 0.77 | 0.19 | 4.30 | 0.079 | 1.00 | 5,500 | 5521 | 5627 | 0.024 | 0.054 |
| 126 | NAX | Nonane (all isomers) | D | 1 | 0.72 | 0.27 | 4.40 | 0.080 | 1.01 | 5,500 | 5530 | 5684 | 0.024 | 0.056 |
| 127 | NON | Nonene (all isomers) | D | 2 | 0.73 | 0.35 | 4.30 | 0.082 | 1.01 | 5,500 | 5539 | 5733 | 0.025 | 0.057 |
| 128 | NNS | Nonyl Alcohol (all isomers) | D | 1 | 0.94 | 0.10 | 5.00 | 0.078 | 1.00 | 5,500 | 5511 | 5579 | 0.023 | 0.054 |
| 129 | NNP | Nonyl Phenol | D | 1 | 0.95 | 0.01 | 7.60 | 0.076 | 1.00 | 5,500 | 5501 | 5512 | 0.023 | 0.052 |
| 130 | NPM | 1-, 2-Nitropropane | III | 1 | 0.99 | 1.05 | 3.06 | 0.086 | 1.02 | 5,500 | 5616 | 5979 | 0.027 | 0.062 |
| 131 | OAX | Octane (all isomers) | D | 1 | 0.70 | 0.79 | 3.90 | 0.087 | 1.02 | 5,500 | 5587 | 5969 | 0.027 | 0.061 |
| 132 | OCX | Octanol (all isomers) | D | 1 | 0.83 | 0.01 | 4.48 | 0.076 | 1.00 | 5,500 | 5501 | 5507 | 0.023 | 0.052 |
| 133 | OTX | Octene (all isomers) | D | 2 | 0.72 | 0.90 | 3.90 | 0.088 | 1.02 | 5,500 | 5599 | 6033 | 0.027 | 0.063 |
| 134 | OTW | Oil, fuel: No. 2 | D | 1 | 0.88 | 0.56 | 8.00 | 0.095 | 1.01 | 5,500 | 5562 | 6198 | 0.029 | 0.066 |
| 135 | OTD | Oil, fuel: No. 2-D | D | 1 | 0.90 | 0.69 | 3.40 | 0.084 | 1.01 | 5,500 | 5576 | 5853 | 0.026 | 0.059 |
| 136 | OFR | Oil, fuel: No. 4 | D | 1 | 0.90 | 0.15 | 3.40 | 0.078 | 1.00 | 5,500 | 5517 | 5577 | 0.023 | 0.054 |
| 137 | OFV | Oil, fuel: No. 5 | D | 1 | 0.94 | 0.15 | 3.40 | 0.078 | 1.00 | 5,500 | 5517 | 5577 | 0.023 | 0.054 |
| 138 | OSX | Oil, fuel: No. 6 | D | 1 | 0.95 | 0.15 | 3.40 | 0.078 | 1.00 | 5,500 | 5517 | 5577 | 0.023 | 0.054 |
| 139 | OIL | Oil, misc: Crude | D | 1 | 0.95 | 0.15 | 3.40 | 0.078 | 1.25 | 5,500 | 6875 | 6951 | 0.036 | 0.083 |
| 140 | ODS | Oil, Misc: Diesel | D | 1 | 0.90 | 0.69 | 3.40 | 0.084 | 1.01 | 5,500 | 5576 | 5854 | 0.026 | 0.059 |
| 141 | OLB | Oil, Misc: Lubricating | D | 1 | 0.90 | 0.15 | 1.00 | 0.076 | 1.00 | 5,500 | 5517 | 5517 | 0.023 | 0.052 |
| 142 | ORL | Oil, Misc: Residual | D | 1 | 1.02 | 0.15 | 1.00 | 0.076 | 1.00 | 5,500 | 5517 | 5517 | 0.023 | 0.052 |
| 143 | OTB | Oil, Misc: Turbine | D | 1 | 0.87 | 0.30 | 5.40 | 0.082 | 1.01 | 5,500 | 5533 | 5754 | 0.025 | 0.057 |
| 144 | PTY | Pentane (all isomers) | D | 5 | 0.63 | 27.00 | 2.50 | 0.350 | 1.54 | 5,500 | 8470 | 18150 | 0.249 | 0.567 |
| 145 | PTE | Pentene (all isomers) | D | 5 | 0.64 | 24.95 | 2.40 | 0.310 | 1.50 | 5,500 | 8245 | 16640 | 0.209 | 0.477 |
| 146 | PIN | Pinene | D | 1 | 0.86 | 0.38 | 4.70 | 0.083 | 1.01 | 5,500 | 5542 | 5777 | 0.025 | 0.057 |
| 147 | PLB | Polybutene | D | 1 | 0.91 | 0.01 | 1.00 | 0.076 | 1.00 | 5,500 | 5501 | 5501 | 0.023 | 0.052 |
| 148 | PGC | Polypropylene Glycol | D | 1 | 1.01 | 0.10 | 1.00 | 0.076 | 1.00 | 5,500 | 5511 | 5511 | 0.023 | 0.052 |
| 149 | IAC | Propyl Acetate (iso-) | D | 1 | 0.89 | 1.80 | 3.52 | 0.097 | 1.04 | 5,500 | 5698 | 6447 | 0.031 | 0.072 |
| 150 | PAT | Propyl Acetate (n-) | D | 1 | 0.00 | 1.85 | 3.52 | 0.098 | 1.04 | 5,500 | 5704 | 6472 | 0.032 | 0.072 |
| 151 | IPA | Propyl Alcohol (iso-) | D | 1 | 0.79 | 3.00 | 2.07 | 0.091 | 1.06 | 5,500 | 5830 | 6382 | 0.031 | 0.070 |
| 152 | PAL | Propyl Alcohol (n-) | D | 1 | 0.80 | 1.20 | 2.07 | 0.082 | 1.02 | 5,500 | 5632 | 5851 | 0.026 | 0.059 |
| 153 | PBY | Propylbenzene (all isomers) | D | 1 | 0.86 | 0.20 | 4.14 | 0.079 | 1.00 | 5,500 | 5522 | 5628 | 0.024 | 0.055 |
| 154 | IPX | iso-Propylcyclohexane | D | 1 | 0.80 | 0.01 | 4.35 | 0.076 | 1.00 | 5,500 | 5501 | 5507 | 0.023 | 0.052 |
| 155 | PPG | Propylene Glycol | D | 1 | 1.04 | 0.01 | 2.62 | 0.076 | 1.00 | 5,500 | 5501 | 5504 | 0.023 | 0.052 |
| 156 | PGN | Propylene Glycol Methyl Ether Acetate | D | 1 | 0.92 | 0.70 | 3.11 | 0.083 | 1.01 | 5,500 | 5577 | 5826 | 0.026 | 0.058 |
| 157 | PTT | Propylene Tetramer | D | 1 | 0.29 | 0.02 | 1.00 | 0.076 | 1.00 | 5,500 | 5502 | 5502 | 0.023 | 0.052 |
| 158 | SFL | Sulfolane | D | 1 | 1.26 | 0.01 | 4.14 | 0.076 | 1.00 | 5,500 | 5501 | 5506 | 0.023 | 0.052 |
| 159 | STY | Styrene | III | 2 | 0.92 | 0.40 | 3.60 | 0.081 | 1.01 | 5,500 | 5544 | 5719 | 0.025 | 0.056 |
| 160 | TTG | Tetraethylene Glycol | D | 1 | 1.20 | 0.01 | 6.70 | 0.076 | 1.00 | 5,500 | 5501 | 5511 | 0.023 | 0.052 |

| | CHRIS Code | Name | Type | VCS Category | Liquid S.G. | *Vapor Press. @ 115 F (psia) | Vapor S.G. | Vapor-air Mixture Weight Density (lb/ft^3) | Vapor Growth Rate | Max. Loading Rate | Vapor Volumetric Flow Rate (bbl/hr) | Air Equivalent Volumetric Flow Rate (bbl/hr) | Pressure Drop to PV Valve in VCS (See Table 3) (psig) | Pressure Drop to Facility Connection in VCS (See Table 5) (psig) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 161 | THN | Tetrahydronaphthalene | D | 1 | 0.97 | 0.04 | 4.56 | 0.077 | 1.00 | 5,500 | 5504 | 5529 | 0.023 | 0.053 |
| 162 | TOL | Toluene | D | 1 | 0.87 | 1.50 | 3.14 | 0.091 | 1.03 | 5,500 | 5665 | 6201 | 0.029 | 0.066 |
| 163 | TCN | 1,2,3-Trichloropropane | II | 3 | 1.39 | 0.15 | 5.60 | 0.079 | 1.00 | 5,500 | 5517 | 5633 | 0.024 | 0.055 |
| 164 | TCP | Tricresyl Phosphate (less than 1% of ortho | D | 1 | 1.16 | 0.01 | 12.69 | 0.077 | 1.00 | 5,500 | 5501 | 5521 | 0.023 | 0.052 |
| 165 | TEB | Triethylbenzene | D | 1 | 0.86 | 0.02 | 5.60 | 0.077 | 1.00 | 5,500 | 5502 | 5518 | 0.023 | 0.052 |
| 166 | TEN | Triethylamine | II | 3 | 0.73 | 2.50 | 3.49 | 0.105 | 1.05 | 5,500 | 5775 | 6795 | 0.035 | 0.079 |
| 167 | TEG | Triethylene Glycol | D | 1 | 1.12 | 0.01 | 5.17 | 0.076 | 1.00 | 5,500 | 5501 | 5508 | 0.023 | 0.052 |
| 168 | TPS | Triethyl Phosphate | D | 1 | 1.07 | 0.03 | 6.28 | 0.077 | 1.00 | 5,500 | 5503 | 5530 | 0.023 | 0.053 |
| 169 | TRE | Trimethylbenzene (all isomers) | D | 1 | 0.89 | 0.14 | 4.20 | 0.078 | 1.00 | 5,500 | 5515 | 5588 | 0.024 | 0.054 |
| 170 | TRP | Trixylenyl Phosphate | D | 1 | 1.16 | 0.00 | 14.20 | 0.076 | 1.00 | 5,500 | 5500 | 5500 | 0.023 | 0.052 |
| 171 | THF | Tetrahydrofuran | III | 1 | 0.89 | 8.50 | 1.35 | 0.090 | 1.17 | 5,500 | 6435 | 7001 | 0.037 | 0.084 |
| 172 | UDC | Undecene | D | 1 | 0.75 | 0.05 | 5.32 | 0.077 | 1.00 | 5,500 | 5506 | 5542 | 0.023 | 0.053 |
| 173 | UND | Undecyl Alcohol | D | 1 | 0.84 | 0.01 | 5.94 | 0.076 | 1.00 | 5,500 | 5501 | 5509 | 0.023 | 0.052 |
| 174 | VAM | Vinyl Acetate | III | 2 | 0.94 | 5.80 | 2.97 | 0.130 | 1.12 | 5,500 | 6138 | 8015 | 0.048 | 0.111 |
| 175 | XLX | Xylenes (ortho-, meta-, para-) | D | 1 | 0.89 | 0.51 | 3.68 | 0.083 | 1.01 | 5,500 | 5556 | 5786 | 0.025 | 0.058 |
| | | | | | | | max = | 0.350 | 1.54 | | | max = | 0.249 | 0.567 |

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

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

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

Calculate equivalent lengths of pipe:

a. Pipe run #1

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

| Item | Description | Size (in) | Qty | Unit Equivalent Length (ft) | Total Equivalent Length (ft) |
|---|---|---|---|---|---|
| | | | | | |
| 1 | Entrance | 8 | 1 | 23.3 | 23.3 |
| 2 | Straight Pipe | 8 | 1 | 53.0 | 53.0 |
| 3 | Tee, branch | 8 | 2 | 40.0 | 80.0 |
| 4 | Tee, flow | 8 | 1 | 14.0 | 14.0 |
| 5 | | | | | 0.0 |
| 6 | | | | | |
| | Sum (pipe run #1) | | | | 170.3 |

b. Pipe run #2

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

| Item | Description | Size (in) | Qty | Unit Equivalent Length (ft) | Total Equivalent Length (ft) |
|---|---|---|---|---|---|
| | | | | | |
| 1 | Straight Pipe | 6 | 1 | 3.0 | 3.0 |
| 2 | Sudden Contraction (8x6) | 6 | 1 | 8.0 | 8.0 |
| | Sum (pipe run #2) | | | | 11.0 |

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

A. Calculate pressure drop using Darcy's equation:

| | | | | | | Pipe run #1 | | | Pipe run #2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Description: 8" Branch (Exp trunk to vapor stack) | | | Description: 6" branch at P-V valve | | | | |
| | | | | | | Pipe ID: 7.98 (in) | | | Pipe ID: 6.07 (in) | | | | |
| | | | | | | Equiv. Pipe Length (table 2a): 170.3 (feet) | | | Equiv. Pipe Length (table 2b): 11.0 (feet) | | | | |
| | | | | | | Darcy friction factor: 0.014 | | | Darcy friction factor: 0.015 | | | | |
| | CHRIS Code | Name | Vapor-air Mixture Weight Density (from Table 1) (lb/ft^3) | Liquid Transfer Rate (filling) (bbl/hr) | Vapor Growth Rate | Vapor Volumetric Flow Rate (bbl/hr) | Mean Velocity (ft/s) | Pressure Drop (pipe run #1) (psig) | Vapor Volumetric Flow Rate (bbl/hr) | Mean Velocity (ft/s) | Pressure Drop (pipe run #2) (psig) | Pressure Drop (Total) (psig) | Air Equiv. Volumetric Flow Rate (bbl/hr) |
| 1 | ACN | Acrylonitrile | 0.095 | 5,500 | 1.100 | 6050 | 27.16 | 0.027 | 6050 | 46.95 | 0.007 | 0.034 | 5756 |
| 2 | ACT | Acetone | 0.123 | 5,500 | 1.200 | 6600 | 29.63 | 0.042 | 6600 | 51.22 | 0.011 | 0.053 | 8393 |
| 3 | ACP | Acetophenone | 0.085 | 5,500 | 1.012 | 5566 | 24.99 | 0.021 | 5566 | 43.19 | 0.006 | 0.026 | 5881 |
| 4 | AND | Adiponitrile | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5506 |
| 5 | AEC | Amyl acetate (all isomers) | 0.075 | 5,500 | 1.007 | 5536 | 24.86 | 0.018 | 5536 | 42.96 | 0.005 | 0.023 | 5485 |
| 6 | AAI | Amyl Alcohol (iso-, n-, sec-, primary) | 0.079 | 5,500 | 1.006 | 5533 | 24.84 | 0.019 | 5533 | 42.94 | 0.005 | 0.024 | 5637 |
| 7 | ATN | Acetonitrile | 0.076 | 5,500 | 1.001 | 5503 | 24.71 | 0.018 | 5503 | 42.71 | 0.005 | 0.023 | 5505 |
| 8 | BAL | Benzyl Alcohol | 0.077 | 5,500 | 1.002 | 5511 | 24.74 | 0.018 | 5511 | 42.77 | 0.005 | 0.023 | 5557 |
| 9 | BNZ | Benzene | 0.114 | 5,500 | 1.250 | 6875 | 30.87 | 0.042 | 6875 | 53.35 | 0.011 | 0.054 | 8420 |
| 10 | BTX | Benzene, Toluene, Xylene mixtures (10% Benzen | 0.138 | 5,500 | 1.250 | 6875 | 30.87 | 0.051 | 6875 | 53.35 | 0.014 | 0.065 | 9252 |
| 11 | BAR | Butyl Acrylate (iso-, n-) | 0.086 | 5,500 | 1.012 | 5566 | 24.99 | 0.021 | 5566 | 43.19 | 0.006 | 0.026 | 5908 |
| 12 | BAX | Butyl Acetate (all isomers) | 0.085 | 5,500 | 1.012 | 5566 | 24.99 | 0.020 | 5566 | 43.19 | 0.006 | 0.026 | 5867 |
| 13 | IAL | Butyl Alcohol (iso-) | 0.083 | 5,500 | 1.018 | 5599 | 25.14 | 0.020 | 5599 | 43.45 | 0.006 | 0.026 | 5843 |
| 14 | BAN | Butyl Alcohol (n-) | 0.074 | 5,500 | 1.010 | 5555 | 24.94 | 0.018 | 5555 | 43.11 | 0.005 | 0.023 | 5477 |
| 15 | BAS | Butyl Alcohol (sec-) | 0.086 | 5,500 | 1.026 | 5643 | 25.34 | 0.021 | 5643 | 43.79 | 0.006 | 0.027 | 5994 |
| 16 | BAT | Butyl Alcohol (tert-) | 0.097 | 5,500 | 1.056 | 5808 | 26.08 | 0.026 | 5808 | 45.07 | 0.007 | 0.032 | 6562 |
| 17 | BPH | Butyl Benzyl Phthalate | 0.077 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5518 |
| 18 | BAD | iso-Butyraldehyde | 0.131 | 5,500 | 1.156 | 6358 | 28.55 | 0.041 | 6358 | 49.34 | 0.011 | 0.053 | 8344 |
| 19 | BTR | n-Butyraldehyde | 0.131 | 5,500 | 1.156 | 6358 | 28.55 | 0.041 | 6358 | 49.34 | 0.011 | 0.053 | 8344 |
| 20 | BUE | Butyl Toluene | 0.078 | 5,500 | 1.002 | 5511 | 24.74 | 0.018 | 5511 | 42.77 | 0.005 | 0.024 | 5580 |
| 21 | CLS | Caprolactam Solutions | 0.077 | 5,500 | 1.001 | 5506 | 24.72 | 0.018 | 5506 | 42.72 | 0.005 | 0.023 | 5530 |
| 22 | CCH | Cyclohexanone (Anolone) | 0.078 | 5,500 | 1.004 | 5522 | 24.79 | 0.019 | 5522 | 42.85 | 0.005 | 0.024 | 5603 |
| 23 | CHA | Cyclohexylamine | 0.083 | 5,500 | 1.012 | 5568 | 25.00 | 0.020 | 5568 | 43.21 | 0.005 | 0.026 | 5820 |
| 24 | CHX | Cyclohexane | 0.116 | 5,500 | 1.090 | 5995 | 26.92 | 0.033 | 5995 | 46.52 | 0.009 | 0.041 | 7410 |
| 25 | CHN | Cyclohexanol | 0.078 | 5,500 | 1.003 | 5517 | 24.77 | 0.018 | 5517 | 42.81 | 0.005 | 0.023 | 5579 |
| 26 | CPD | 1,3-Cyclopentadiene dimer (molten) | 0.080 | 5,500 | 1.005 | 5528 | 24.82 | 0.019 | 5528 | 42.90 | 0.005 | 0.024 | 5677 |
| 27 | CMP | p-Cymene | 0.078 | 5,500 | 1.002 | 5512 | 24.75 | 0.018 | 5512 | 42.78 | 0.005 | 0.023 | 5579 |
| 28 | CRB | Chlorobenzene | 0.087 | 5,500 | 1.016 | 5588 | 25.09 | 0.021 | 5588 | 43.36 | 0.006 | 0.027 | 5972 |
| 29 | CRS | Cresols | 0.077 | 5,500 | 1.002 | 5509 | 24.73 | 0.018 | 5509 | 42.75 | 0.005 | 0.023 | 5546 |
| 30 | CUM | Cumene | 0.085 | 5,500 | 1.012 | 5566 | 24.99 | 0.021 | 5566 | 43.19 | 0.006 | 0.026 | 5887 |
| 31 | IDA | Decaldehyde (iso-) | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5508 |
| 32 | DAL | Decaldehyde (n-) | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.018 | 5500 | 42.68 | 0.005 | 0.023 | 5500 |
| 33 | DCE | Decene | 0.078 | 5,500 | 1.002 | 5513 | 24.75 | 0.019 | 5513 | 42.78 | 0.005 | 0.024 | 5590 |
| 34 | DAX | Decyl Alcohol (all isomers) (Decanol) | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5508 |
| 35 | DBZ | Decylbenzene (n-) | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5512 |
| 36 | DAA | Diacetone Alcohol | 0.078 | 5,500 | 1.002 | 5511 | 24.74 | 0.018 | 5511 | 42.77 | 0.005 | 0.023 | 5562 |
| 37 | DCH | 1,1-Dicholoroethane | 0.188 | 5,500 | 1.198 | 6589 | 29.59 | 0.064 | 6589 | 51.13 | 0.017 | 0.081 | 10361 |
| 38 | DPA | Dibutyl Phthalate (ortho-) | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.018 | 5500 | 42.68 | 0.005 | 0.023 | 5500 |
| 39 | DEB | Diethybenzene | 0.078 | 5,500 | 1.002 | 5509 | 24.73 | 0.018 | 5509 | 42.75 | 0.005 | 0.023 | 5558 |
| 40 | DEG | Diethylene Glycol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5506 |
| 41 | DEN | Diethylamine | 0.083 | 5,500 | 1.020 | 5610 | 25.19 | 0.020 | 5610 | 43.54 | 0.006 | 0.026 | 5864 |
| 42 | DBL | Diisobulylene | 0.103 | 5,500 | 1.040 | 5720 | 25.68 | 0.026 | 5720 | 44.39 | 0.007 | 0.033 | 6654 |
| 43 | DIK | Diisobutyl Ketone | 0.079 | 5,500 | 1.003 | 5518 | 24.77 | 0.019 | 5518 | 42.82 | 0.005 | 0.024 | 5623 |
| 44 | DIP | Diisopropanolamme | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5507 |
| 45 | DIX | Diisopropylbenzene (all isomers) | 0.077 | 5,500 | 1.001 | 5503 | 24.71 | 0.018 | 5503 | 42.71 | 0.005 | 0.023 | 5527 |
| 46 | DTL | Dimethyl Phthalate | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.018 | 5500 | 42.68 | 0.005 | 0.023 | 5500 |
| 47 | DOP | Dioctyl Phthalate | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.018 | 5500 | 42.68 | 0.005 | 0.023 | 5500 |
| 48 | DPN | Dipentene | 0.078 | 5,500 | 1.002 | 5511 | 24.74 | 0.018 | 5511 | 42.77 | 0.005 | 0.023 | 5577 |
| 49 | DIL | Diphenyl | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5508 |
| 50 | DDO | Diphenyl, Diphenyl Ether Mixtures | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5509 |
| 51 | DMF | Dimethylformamide | 0.078 | 5,500 | 1.006 | 5533 | 24.84 | 0.019 | 5533 | 42.94 | 0.005 | 0.024 | 5610 |
| 52 | DPE | Diphenyl Ether | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5509 |
| 53 | DPG | Dipropylene Glycol | 0.077 | 5,500 | 1.001 | 5508 | 24.73 | 0.018 | 5508 | 42.74 | 0.005 | 0.023 | 5551 |
| 54 | DPX | 1,1-, 1,2-, 1,3-Dichloropropane | 0.162 | 5,500 | 1.126 | 6193 | 27.81 | 0.048 | 6193 | 48.06 | 0.013 | 0.062 | 9034 |
| 55 | DFF | Distillates Flashed Feed Stocks | 0.102 | 5,500 | 1.046 | 5753 | 25.83 | 0.026 | 5753 | 44.65 | 0.007 | 0.033 | 6661 |
| 56 | DSR | Distillates Straight Run | 0.102 | 5,500 | 1.046 | 5753 | 25.83 | 0.026 | 5753 | 44.65 | 0.007 | 0.033 | 6661 |
| 57 | DOZ | Dodecene (all isomers) | 0.077 | 5,500 | 1.000 | 5502 | 24.71 | 0.018 | 5502 | 42.70 | 0.005 | 0.023 | 5519 |
| 58 | DDB | Dodecylbenzene | 0.240 | 5,500 | 1.250 | 6875 | 30.87 | 0.088 | 6875 | 53.35 | 0.024 | 0.112 | 12196 |
| 59 | EAC | Ethyl Acrylate | 0.100 | 5,500 | 1.040 | 5720 | 25.68 | 0.025 | 5720 | 44.39 | 0.007 | 0.032 | 6543 |
| 60 | EAI | 2-Ethylhexyl acrylate | 0.077 | 5,500 | 1.000 | 5502 | 24.71 | 0.018 | 5502 | 42.70 | 0.005 | 0.023 | 5520 |
| 61 | EEA | 2-Ethoxyethyl acetate | 0.077 | 5,500 | 1.000 | 5503 | 24.71 | 0.018 | 5503 | 42.70 | 0.005 | 0.023 | 5517 |
| 62 | ETG | Ethoxy Triglycol (crude) | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.018 | 5500 | 42.68 | 0.005 | 0.023 | 5500 |
| 63 | ETA | Ethyl Acetate | 0.119 | 5,500 | 1.090 | 5995 | 26.92 | 0.033 | 5995 | 46.52 | 0.009 | 0.042 | 7504 |
| 64 | EAA | Ethyl Acetoacetate | 0.079 | 5,500 | 1.004 | 5522 | 24.79 | 0.019 | 5522 | 42.85 | 0.005 | 0.024 | 5639 |
| 65 | EAL | Ethyl Alcohol (Ethanol) | 0.086 | 5,500 | 1.070 | 5885 | 26.42 | 0.023 | 5885 | 45.67 | 0.006 | 0.030 | 6255 |
| 66 | ETB | Ethyl Benzene | 0.083 | 5,500 | 1.012 | 5566 | 24.99 | 0.020 | 5566 | 43.19 | 0.005 | 0.026 | 5824 |
| 67 | EBT | Ethyl Butanol | 0.078 | 5,500 | 1.002 | 5513 | 24.75 | 0.018 | 5513 | 42.78 | 0.005 | 0.023 | 5564 |
| 68 | EBE | Ethyl tert-butyl ether | 0.078 | 5,500 | 1.004 | 5521 | 24.79 | 0.019 | 5521 | 42.85 | 0.005 | 0.024 | 5602 |
| 69 | EBR | Ethyl butyrate | 0.090 | 5,500 | 1.020 | 5610 | 25.19 | 0.022 | 5610 | 43.54 | 0.006 | 0.028 | 6107 |
| 70 | ECY | Ethyl Cyclohexane | 0.083 | 5,500 | 1.010 | 5555 | 24.94 | 0.020 | 5555 | 43.11 | 0.005 | 0.025 | 5796 |
| 71 | EDC | Ethylene dichloride | 0.122 | 5,500 | 1.080 | 5940 | 26.67 | 0.033 | 5940 | 46.10 | 0.009 | 0.043 | 7508 |
| 72 | EGL | Ethylene Glycol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5503 |
| 73 | EMA | Ethylene Glycol Butyl Ether Acetate | 0.077 | 5,500 | 1.001 | 5506 | 24.72 | 0.018 | 5506 | 42.72 | 0.005 | 0.023 | 5544 |
| 74 | EGY | Ethylene Glycol Diacetate | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5508 |
| 75 | EPE | Ethylene Glycol Phenyl Ether | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5508 |
| 76 | EEP | Ethyl-3-ethoxypropionate | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5510 |
| 77 | EHX | 2-Ethylhexanol (Octanol) | 0.076 | 5,500 | 1.000 | 5502 | 24.71 | 0.018 | 5502 | 42.70 | 0.005 | 0.023 | 5514 |
| 78 | EPR | Ethyl Propionate | 0.086 | 5,500 | 1.070 | 5885 | 26.42 | 0.023 | 5885 | 45.67 | 0.006 | 0.030 | 6255 |
| 79 | ETE | Ethyl Toluene | 0.080 | 5,500 | 1.006 | 5531 | 24.83 | 0.019 | 5531 | 42.92 | 0.005 | 0.024 | 5679 |
| 80 | FAM | Formamide | 0.076 | 5,500 | 1.002 | 5511 | 24.74 | 0.018 | 5511 | 42.77 | 0.005 | 0.023 | 5520 |
| 81 | FMS | Formaldehyde Solution | 0.076 | 5,500 | 1.003 | 5517 | 24.77 | 0.018 | 5517 | 42.81 | 0.005 | 0.023 | 5517 |
| 82 | FAL | Furfuryl Alcohol | 0.077 | 5,500 | 1.001 | 5506 | 24.72 | 0.018 | 5506 | 42.72 | 0.005 | 0.023 | 5526 |
| 83 | FFA | Furfural | 0.078 | 5,500 | 1.003 | 5517 | 24.77 | 0.018 | 5517 | 42.81 | 0.005 | 0.023 | 5575 |
| 84 | GAK | Gasoline Blending Stocks: Alkylates | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.080 | 6875 | 53.35 | 0.022 | 0.102 | 11610 |
| 85 | GRF | Gasoline Blending Stocks: Reformates | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.080 | 6875 | 53.35 | 0.022 | 0.102 | 11610 |
| 86 | GAT | Gasolines: Automotive | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.080 | 6875 | 53.35 | 0.022 | 0.102 | 11610 |
| 87 | GAV | Gasolines: Aviation | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.080 | 6875 | 53.35 | 0.022 | 0.102 | 11610 |
| 88 | GCS | Gasolines: Casinghead | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.080 | 6875 | 53.35 | 0.022 | 0.102 | 11610 |
| 89 | GPL | Gasolines: Polymer | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.080 | 6875 | 53.35 | 0.022 | 0.102 | 11610 |
| 90 | GSR | Gasolines: StraightRun | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.080 | 6875 | 53.35 | 0.022 | 0.102 | 11610 |
| 91 | GCR | Glycerine | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.018 | 5500 | 42.68 | 0.005 | 0.023 | 5500 |
| 92 | HMX | Heptane (all isomers) | 0.105 | 5,500 | 1.050 | 5775 | 25.93 | 0.027 | 5775 | 44.82 | 0.007 | 0.035 | 6779 |
| 93 | HEP | Heptonic Acid | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5507 |
| 94 | HTX | Heptanol (all isomers) | 0.077 | 5,500 | 1.001 | 5504 | 24.72 | 0.018 | 5504 | 42.72 | 0.005 | 0.023 | 5525 |
| 95 | HPX | Heptene (all isomers) | 0.109 | 5,500 | 1.058 | 5819 | 26.13 | 0.029 | 5819 | 45.16 | 0.008 | 0.037 | 6958 |
| 96 | HXS | Hexane (all isomers) | 0.142 | 5,500 | 1.140 | 6270 | 28.15 | 0.043 | 6270 | 48.66 | 0.012 | 0.055 | 8561 |
| 97 | HXO | Hexanoic Acid | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5506 |
| 98 | HXN | Hexanol | 0.088 | 5,500 | 1.020 | 5610 | 25.19 | 0.022 | 5610 | 43.54 | 0.006 | 0.027 | 6031 |
| 99 | HEX | Hexene (all isomers) | 0.148 | 5,500 | 1.160 | 6380 | 28.65 | 0.047 | 6380 | 49.51 | 0.013 | 0.060 | 8882 |

| | | | | | | Pipe run #1 | | | Pipe run #2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Description: | 8" Branch (Exp trunk to vapor stack) | | Description: | 6" branch at P-V valve | | | |
| | | | | | | Pipe ID: | 7.98 (in) | | Pipe ID: | 6.07 (in) | | | |
| | | | | | | Equiv. Pipe Length (table 2a): | 170.3 (feet) | | Equiv. Pipe Length (table 2b): | 11.0 (feet) | | | |
| | | | | | | Darcy friction factor: | 0.014 | | Darcy friction factor: | 0.015 | | | |
| | CHRIS Code | Name | Vapor-air Mixture Weight Density (from Table 1) (lb/ft^3) | Liquid Transfer Rate (filling) (bbl/hr) | Vapor Growth Rate | Vapor Volumetric Flow Rate (bbl/hr) | Mean Velocity (ft/s) | Pressure Drop (pipe run #1) (psig) | Vapor Volumetric Flow Rate (bbl/hr) | Mean Velocity (ft/s) | Pressure Drop (pipe run #2) (psig) | Pressure Drop (Total) (psig) | Air Equiv. Volumetric Flow Rate (bbl/hr) |
| 100 | HXG | Hexylene Glycol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5501 |
| 101 | IPH | Isophorone | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5507 |
| 102 | JPF | Jet Fuels: JP-4 | 0.124 | 5,500 | 1.068 | 5874 | 26.37 | 0.033 | 5874 | 45.58 | 0.009 | 0.042 | 7499 |
| 103 | JPV | Jet Fuels JP-5 (Kerosene, heavy) | 0.078 | 5,500 | 1.002 | 5511 | 24.74 | 0.018 | 5511 | 42.77 | 0.005 | 0.023 | 5562 |
| 104 | KRS | Kerosene | 0.079 | 5,500 | 1.003 | 5517 | 24.77 | 0.019 | 5517 | 42.81 | 0.005 | 0.024 | 5605 |
| 105 | MTT | Methyl Acetate | 0.122 | 5,500 | 1.122 | 6171 | 27.71 | 0.036 | 6171 | 47.89 | 0.010 | 0.046 | 7812 |
| 106 | MAL | Methyl Alcohol (Methanol) | 0.079 | 5,500 | 1.133 | 6229 | 27.97 | 0.024 | 6229 | 48.34 | 0.007 | 0.030 | 6355 |
| 107 | MAC | Methylamyl Acetate | 0.082 | 5,500 | 1.007 | 5536 | 24.86 | 0.020 | 5536 | 42.96 | 0.005 | 0.025 | 5756 |
| 108 | MAA | Methylamyl Alcohol | 0.081 | 5,500 | 1.009 | 5547 | 24.91 | 0.019 | 5547 | 43.05 | 0.005 | 0.025 | 5730 |
| 109 | MAK | Methylamyl Keytone | 0.076 | 5,500 | 1.001 | 5506 | 24.72 | 0.018 | 5506 | 42.72 | 0.005 | 0.023 | 5506 |
| 110 | MAM | Methyl Acrylate | 0.115 | 5,500 | 1.082 | 5951 | 26.72 | 0.032 | 5951 | 46.18 | 0.009 | 0.040 | 7303 |
| 111 | MBE | Methyl Tert-Butyl Ether (MTBE) | 0.077 | 5,500 | 1.001 | 5504 | 24.72 | 0.018 | 5504 | 42.72 | 0.005 | 0.023 | 5519 |
| 112 | MBK | Methyl Butyl Ketone | 0.088 | 5,500 | 1.019 | 5607 | 25.17 | 0.021 | 5607 | 43.51 | 0.006 | 0.027 | 6012 |
| 113 | MBU | Methyl Butyrate | 0.091 | 5,500 | 1.025 | 5639 | 25.32 | 0.023 | 5639 | 43.76 | 0.006 | 0.029 | 6168 |
| 114 | MEK | Methyl Ethyl Ketone | 0.108 | 5,500 | 1.090 | 5995 | 26.92 | 0.030 | 5995 | 46.52 | 0.008 | 0.038 | 7135 |
| 115 | MHK | Methyl Heptyl Ketone | 0.077 | 5,500 | 1.001 | 5507 | 24.73 | 0.018 | 5507 | 42.73 | 0.005 | 0.023 | 5546 |
| 116 | MIK | Methyl Isobutyl Ketone | 0.089 | 5,500 | 1.023 | 5627 | 25.26 | 0.022 | 5627 | 43.66 | 0.006 | 0.028 | 6096 |
| 117 | MMM | Methyl methacrylate | 0.099 | 5,500 | 1.040 | 5722 | 25.69 | 0.025 | 5722 | 44.41 | 0.007 | 0.032 | 6538 |
| 118 | MNA | Methyl Naphthalene | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5508 |
| 119 | MNS | Mineral Spirits | 0.079 | 5,500 | 1.004 | 5522 | 24.79 | 0.019 | 5522 | 42.85 | 0.005 | 0.024 | 5633 |
| 120 | MPL | Morpholine | 0.084 | 5,500 | 1.016 | 5588 | 25.09 | 0.020 | 5588 | 43.36 | 0.006 | 0.026 | 5857 |
| 121 | MRE | Myrcene | 0.079 | 5,500 | 1.003 | 5519 | 24.78 | 0.019 | 5519 | 42.83 | 0.005 | 0.024 | 5625 |
| 122 | PTN | Naphtha: Petroleum | 0.078 | 5,500 | 1.004 | 5521 | 24.79 | 0.019 | 5521 | 42.84 | 0.005 | 0.024 | 5600 |
| 123 | NSV | Naphtha: Solvent | 0.078 | 5,500 | 1.004 | 5522 | 24.79 | 0.019 | 5522 | 42.85 | 0.005 | 0.024 | 5607 |
| 124 | NSS | Naphtha: Stoddard Solvent | 0.079 | 5,500 | 1.004 | 5522 | 24.79 | 0.019 | 5522 | 42.85 | 0.005 | 0.024 | 5633 |
| 125 | NVM | Naphtha: VM&P | 0.079 | 5,500 | 1.004 | 5521 | 24.79 | 0.019 | 5521 | 42.84 | 0.005 | 0.024 | 5627 |
| 126 | NAX | Nonane (all isomers) | 0.080 | 5,500 | 1.005 | 5530 | 24.83 | 0.019 | 5530 | 42.91 | 0.005 | 0.024 | 5684 |
| 127 | NON | Nonene (all isomers) | 0.082 | 5,500 | 1.007 | 5539 | 24.87 | 0.019 | 5539 | 42.98 | 0.005 | 0.025 | 5733 |
| 128 | NNS | Nonyl Alcohol (all isomers) | 0.078 | 5,500 | 1.002 | 5511 | 24.74 | 0.018 | 5511 | 42.77 | 0.005 | 0.023 | 5579 |
| 129 | NNP | Nonyl Phenol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5512 |
| 130 | NPM | 1-, 2-Nitropropane | 0.086 | 5,500 | 1.021 | 5616 | 25.21 | 0.021 | 5616 | 43.58 | 0.006 | 0.027 | 5979 |
| 131 | OAX | Octane (all isomers) | 0.087 | 5,500 | 1.016 | 5587 | 25.09 | 0.021 | 5587 | 43.36 | 0.006 | 0.027 | 5969 |
| 132 | OCX | Octanol (all isomers) | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5507 |
| 133 | OTX | Octene (all isomers) | 0.088 | 5,500 | 1.018 | 5599 | 25.14 | 0.022 | 5599 | 43.45 | 0.006 | 0.027 | 6033 |
| 134 | OTW | Oil, fuel: No. 2 | 0.095 | 5,500 | 1.011 | 5562 | 24.97 | 0.023 | 5562 | 43.16 | 0.006 | 0.029 | 6198 |
| 135 | OTD | Oil, fuel: No. 2-D | 0.084 | 5,500 | 1.014 | 5576 | 25.04 | 0.020 | 5576 | 43.27 | 0.006 | 0.026 | 5853 |
| 136 | OFR | Oil, fuel: No. 4 | 0.078 | 5,500 | 1.003 | 5517 | 24.77 | 0.018 | 5517 | 42.81 | 0.005 | 0.023 | 5577 |
| 137 | OFV | Oil, fuel: No. 5 | 0.078 | 5,500 | 1.003 | 5517 | 24.77 | 0.018 | 5517 | 42.81 | 0.005 | 0.023 | 5577 |
| 138 | OSX | Oil, fuel: No. 6 | 0.078 | 5,500 | 1.003 | 5517 | 24.77 | 0.018 | 5517 | 42.81 | 0.005 | 0.023 | 5577 |
| 139 | OIL | Oil, misc: Crude | 0.078 | 5,500 | 1.250 | 6875 | 30.87 | 0.029 | 6875 | 53.35 | 0.008 | 0.036 | 6951 |
| 140 | ODS | Oil, Misc: Diesel | 0.084 | 5,500 | 1.014 | 5576 | 25.04 | 0.020 | 5576 | 43.27 | 0.006 | 0.026 | 5854 |
| 141 | OLB | Oil, Misc: Lubricating | 0.076 | 5,500 | 1.003 | 5517 | 24.77 | 0.018 | 5517 | 42.81 | 0.005 | 0.023 | 5517 |
| 142 | ORL | Oil, Misc: Residual | 0.076 | 5,500 | 1.003 | 5517 | 24.77 | 0.018 | 5517 | 42.81 | 0.005 | 0.023 | 5517 |
| 143 | OTB | Oil, Misc: Turbine | 0.082 | 5,500 | 1.006 | 5533 | 24.84 | 0.020 | 5533 | 42.94 | 0.005 | 0.025 | 5754 |
| 144 | PTY | Pentane (all isomers) | 0.350 | 5,500 | 1.540 | 8470 | 38.03 | 0.195 | 8470 | 65.73 | 0.053 | 0.249 | 18150 |
| 145 | PTE | Pentene (all isomers) | 0.310 | 5,500 | 1.499 | 8245 | 37.02 | 0.164 | 8245 | 63.98 | 0.045 | 0.209 | 16640 |
| 146 | PIN | Pinene | 0.083 | 5,500 | 1.008 | 5542 | 24.88 | 0.020 | 5542 | 43.01 | 0.005 | 0.025 | 5777 |
| 147 | PLB | Polybutene | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5501 |
| 148 | PGC | Polypropylene Glycol | 0.076 | 5,500 | 1.002 | 5511 | 24.74 | 0.018 | 5511 | 42.77 | 0.005 | 0.023 | 5511 |
| 149 | IAC | Propyl Acetate (iso-) | 0.097 | 5,500 | 1.036 | 5698 | 25.58 | 0.025 | 5698 | 44.22 | 0.007 | 0.031 | 6447 |
| 150 | PAT | Propyl Acetate (n-) | 0.098 | 5,500 | 1.037 | 5704 | 25.61 | 0.025 | 5704 | 44.26 | 0.007 | 0.032 | 6472 |
| 151 | IPA | Propyl Alcohol (iso-) | 0.091 | 5,500 | 1.060 | 5830 | 26.18 | 0.024 | 5830 | 45.24 | 0.007 | 0.031 | 6382 |
| 152 | PAL | Propyl Alcohol (n-) | 0.082 | 5,500 | 1.024 | 5632 | 25.29 | 0.020 | 5632 | 43.71 | 0.006 | 0.026 | 5851 |
| 153 | PBY | Propylbenzene (all isomers) | 0.079 | 5,500 | 1.004 | 5522 | 24.79 | 0.019 | 5522 | 42.85 | 0.005 | 0.024 | 5628 |
| 154 | IPX | iso-Propylcyclohexane | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5507 |
| 155 | PPG | Propylene Glycol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5504 |
| 156 | PGN | Propylene Glycol Methyl Ether Acetate | 0.083 | 5,500 | 1.014 | 5577 | 25.04 | 0.020 | 5577 | 43.28 | 0.005 | 0.026 | 5826 |
| 157 | PTT | Propylene Tetramer | 0.076 | 5,500 | 1.000 | 5502 | 24.71 | 0.018 | 5502 | 42.70 | 0.005 | 0.023 | 5502 |
| 158 | SFL | Sulfolane | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5506 |
| 159 | STY | Styrene | 0.081 | 5,500 | 1.008 | 5544 | 24.89 | 0.019 | 5544 | 43.02 | 0.005 | 0.025 | 5719 |
| 160 | TTG | Tetraethylene Glycol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5511 |
| 161 | THN | Tetrahydronaphthalene | 0.077 | 5,500 | 1.001 | 5504 | 24.72 | 0.018 | 5504 | 42.72 | 0.005 | 0.023 | 5529 |
| 162 | TOL | Toluene | 0.091 | 5,500 | 1.030 | 5665 | 25.44 | 0.023 | 5665 | 43.96 | 0.006 | 0.029 | 6201 |
| 163 | TCN | 1,2,3-Trichloropropane | 0.079 | 5,500 | 1.003 | 5517 | 24.77 | 0.019 | 5517 | 42.81 | 0.005 | 0.024 | 5633 |
| 164 | TCP | Tricresyl Phosphate (less than 1% of ortho isomer | 0.077 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5521 |
| 165 | TEB | Triethylbenzene | 0.077 | 5,500 | 1.000 | 5502 | 24.71 | 0.018 | 5502 | 42.70 | 0.005 | 0.023 | 5518 |
| 166 | TEN | Triethylamine | 0.105 | 5,500 | 1.050 | 5775 | 25.93 | 0.027 | 5775 | 44.82 | 0.007 | 0.035 | 6795 |
| 167 | TEG | Triethylene Glycol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5508 |
| 168 | TPS | Triethyl Phosphate | 0.077 | 5,500 | 1.001 | 5503 | 24.71 | 0.018 | 5503 | 42.71 | 0.005 | 0.023 | 5530 |
| 169 | TRE | Trimethylbenzene (all isomers) | 0.078 | 5,500 | 1.003 | 5515 | 24.76 | 0.019 | 5515 | 42.80 | 0.005 | 0.024 | 5588 |
| 170 | TRP | Trixylenyl Phosphate | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.018 | 5500 | 42.68 | 0.005 | 0.023 | 5500 |
| 171 | THF | Tetrahydrofuran | 0.090 | 5,500 | 1.170 | 6435 | 28.89 | 0.029 | 6435 | 49.94 | 0.008 | 0.037 | 7001 |
| 172 | UDC | Undecene | 0.077 | 5,500 | 1.001 | 5506 | 24.72 | 0.018 | 5506 | 42.72 | 0.005 | 0.023 | 5542 |
| 173 | UND | Undecyl Alcohol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.018 | 5501 | 42.69 | 0.005 | 0.023 | 5509 |
| 174 | VAM | Vinyl Acetate | 0.130 | 5,500 | 1.116 | 6138 | 27.56 | 0.038 | 6138 | 47.63 | 0.010 | 0.048 | 8015 |
| 175 | XLX | Xylenes (ortho-, meta-, para-) | 0.083 | 5,500 | 1.010 | 5556 | 24.95 | 0.020 | 5556 | 43.12 | 0.005 | 0.025 | 5786 |
| | | | | | | | | | | | max = | 0.249 | 18150 |
| | | | | | | | | | | | | cfm = | 1699 |
| | | | | | | | | | | | | m3/h = | 2886 |

Greatest pressure drop to P-V valve: 0.25 (psig) Pentane (all isomers)
High velocity P-V valve pressure setting: 1.50 (psig)
Valve setting + pressure drop in piping = 1.75 (psig)
Back pressure imposed by P-V valve @ highest flow rate 2.64 (psig)
Total back pressure imposed on cargo tank by venting 2.89 (psig) OK
Max design working pressure of tanks: 3.00 (psig)

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

B. Check vacuum relieving capacity at maximum discharge rate:
Opening vacuum setting for PV Valve: 0.5 (psig)
Maximum discharge rate (total): 4300 (bbl/hr) 402 cfm
Corresponding vacuum at max discharge rate: (see attached PV valve flow capacity curve) 0.49 (psig)

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

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

Calculate equivalent lengths of pipe:

a. Pipe run #1

Description: 8" Piping
Pipe size, nominal: 8" sch. 40 pipe
Pipe ID (inches): 7.98

| Item | Description | Size (in) | Qty | Unit Equivalent Length (ft) | Total Equivalent Length (ft) |
|---|---|---|---|---|---|
| | | | | | |
| 1 | Entrance | 8 | 1 | 23.3 | 23.3 |
| 2 | Straight Pipe | 8 | 1 | 190.0 | 190.0 |
| 3 | Tee, branch | 8 | 2 | 40.0 | 80.0 |
| 4 | Tee, flow | 8 | 7 | 14.0 | 98.0 |
| 5 | Elbow, 90 deg. | 8 | 0 | 14.0 | 0.0 |
| 6 | Elbow, 45 deg. | 8 | 4 | 11.0 | 44.0 |
| 7 | Valve, Gate | 8 | 1 | 8.6 | 8.6 |
| 8 | Hose | 8 | 1 | 50.0 | 50.0 |
| | | | | | |
| | Sum (pipe run #1) | | | | 493.9 |

Table 5 Calculation of the Maximum Liquid Transfer Rate as Imposed by the pressure drop between the most remote tank and the facility vapor connection (Ref: 46 CFR 39.30-1(d)(3) (continued):

1. Calculate pressure drop using Darcy's equation:

Pipe run #1

Description: 8" Piping
Pipe ID: 7.98 (in)

Equivalent Length of Pipe (from Table 4a): 493.9 (feet)

Darcy friction factor: 0.014

| | CHRIS Code | Name | Vapor-air Mixture Weight Density (from Table 1) (lb/ft^3) | Liquid Transfer Rate (filling) (bbl/hr) | Vapor Growth Rate | Vapor Volumetric Flow Rate (bbl/hr) | Mean Velocity (ft/s) | Pressure Drop (pipe run #1) (psig) | Pressure Drop (Total) (psig) | Air Equivalent Volumetric Flow Rate (bbl/hr) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ACN | Acrylonitrile | 0.095 | 5,500 | 1.100 | 6050 | 27.16 | 0.079 | 0.079 | 6756 |
| 2 | ACT | Acetone | 0.123 | 5,500 | 1.200 | 6600 | 29.63 | 0.121 | 0.121 | 8393 |
| 3 | ACP | Acetophenone | 0.085 | 5,500 | 1.012 | 5566 | 24.99 | 0.060 | 0.060 | 5881 |
| 4 | AND | Adiponitrile | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5506 |
| 5 | AEC | Amyl acetate (all isomers) | 0.075 | 5,500 | 1.007 | 5536 | 24.86 | 0.052 | 0.052 | 5485 |
| 6 | AAI | Amyl Alcohol (iso-, n-, sec-, primary) | 0.079 | 5,500 | 1.006 | 5533 | 24.84 | 0.055 | 0.055 | 5637 |
| 7 | ATN | Acetonitrile | 0.076 | 5,500 | 1.001 | 5503 | 24.71 | 0.052 | 0.052 | 5505 |
| 8 | BAL | Benzyl Alcohol | 0.077 | 5,500 | 1.002 | 5511 | 24.74 | 0.053 | 0.053 | 5557 |
| 9 | BNZ | Benzene | 0.114 | 5,500 | 1.250 | 6875 | 30.87 | 0.122 | 0.122 | 8420 |
| 10 | BTX | Benzene, Toluene, Xylene mixtures (10% Benzene | 0.138 | 5,500 | 1.250 | 6875 | 30.87 | 0.147 | 0.147 | 9252 |
| 11 | BAR | Butyl Acrylate (iso-, n-) | 0.086 | 5,500 | 1.012 | 5566 | 24.99 | 0.060 | 0.060 | 5908 |
| 12 | BAX | Butyl Acetate (all isomers) | 0.085 | 5,500 | 1.012 | 5566 | 24.99 | 0.059 | 0.059 | 5867 |
| 13 | IAL | Butyl Alcohol (iso-) | 0.083 | 5,500 | 1.018 | 5599 | 25.14 | 0.059 | 0.059 | 5843 |
| 14 | BAN | Butyl Alcohol (n-) | 0.074 | 5,500 | 1.010 | 5555 | 24.94 | 0.052 | 0.052 | 5477 |
| 15 | BAS | Butyl Alcohol (sec-) | 0.086 | 5,500 | 1.026 | 5643 | 25.34 | 0.062 | 0.062 | 5994 |
| 16 | BAT | Butyl Alcohol (tert-) | 0.097 | 5,500 | 1.056 | 5808 | 26.08 | 0.074 | 0.074 | 6562 |
| 17 | BPH | Butyl Benzyl Phthalate | 0.077 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5518 |
| 18 | BAD | iso-Butyraldehyde | 0.131 | 5,500 | 1.156 | 6358 | 28.55 | 0.120 | 0.120 | 8344 |
| 19 | BTR | n-Butyraldehyde | 0.131 | 5,500 | 1.156 | 6358 | 28.55 | 0.120 | 0.120 | 8344 |
| 20 | BUE | Butyl Toluene | 0.078 | 5,500 | 1.002 | 5511 | 24.74 | 0.054 | 0.054 | 5580 |
| 21 | CLS | Caprolactam Solutions | 0.077 | 5,500 | 1.001 | 5506 | 24.72 | 0.053 | 0.053 | 5530 |
| 22 | CCH | Cyclohexanone (Anolone) | 0.078 | 5,500 | 1.004 | 5522 | 24.79 | 0.054 | 0.054 | 5603 |
| 23 | CHA | Cyclohexylamine | 0.083 | 5,500 | 1.012 | 5568 | 25.00 | 0.058 | 0.058 | 5820 |
| 24 | CHX | Cyclohexane | 0.116 | 5,500 | 1.090 | 5995 | 26.92 | 0.094 | 0.094 | 7410 |
| 25 | CHN | Cyclohexanol | 0.078 | 5,500 | 1.003 | 5517 | 24.77 | 0.054 | 0.054 | 5579 |
| 26 | CPD | 1,3-Cyclopentadiene dimer (molten) | 0.080 | 5,500 | 1.005 | 5528 | 24.82 | 0.055 | 0.055 | 5677 |
| 27 | CMP | p-Cymene | 0.078 | 5,500 | 1.002 | 5512 | 24.75 | 0.054 | 0.054 | 5579 |
| 28 | CRB | Chlorobenzene | 0.087 | 5,500 | 1.016 | 5588 | 25.09 | 0.061 | 0.061 | 5972 |
| 29 | CRS | Cresols | 0.077 | 5,500 | 1.002 | 5509 | 24.73 | 0.053 | 0.053 | 5546 |
| 46 | DTL | Dimethyl Phthalate | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.052 | 0.052 | 5500 |
| 47 | DOP | Dioctyl Phthalate | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.052 | 0.052 | 5500 |
| 48 | DPN | Dipentene | 0.078 | 5,500 | 1.002 | 5511 | 24.74 | 0.054 | 0.054 | 5577 |
| 49 | DIL | Diphenyl | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5508 |
| 50 | DDO | Diphenyl, Diphenyl Ether Mixtures | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5509 |
| 51 | DMF | Dimethylformamide | 0.078 | 5,500 | 1.006 | 5533 | 24.84 | 0.054 | 0.054 | 5610 |
| 52 | DPE | Diphenyl Ether | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5509 |
| 53 | DPG | Dipropylene Glycol | 0.077 | 5,500 | 1.001 | 5508 | 24.73 | 0.053 | 0.053 | 5551 |
| 54 | DPX | 1,1-, 1,2-, 1,3-Dichloropropane | 0.162 | 5,500 | 1.126 | 6193 | 27.81 | 0.140 | 0.140 | 9034 |
| 55 | DFF | Distillates Flashed Feed Stocks | 0.102 | 5,500 | 1.046 | 5753 | 25.83 | 0.076 | 0.076 | 6661 |
| 56 | DSR | Distillates Straight Run | 0.102 | 5,500 | 1.046 | 5753 | 25.83 | 0.076 | 0.076 | 6661 |
| 57 | DOZ | Dodecene (all isomers) | 0.077 | 5,500 | 1.000 | 5502 | 24.71 | 0.052 | 0.052 | 5519 |
| 58 | DDB | Dodecylbenzene | 0.240 | 5,500 | 1.250 | 6875 | 30.87 | 0.256 | 0.256 | 12196 |
| 59 | EAC | Ethyl Acrylate | 0.100 | 5,500 | 1.040 | 5720 | 25.68 | 0.074 | 0.074 | 6543 |
| 60 | EAI | 2-Ethylhexyl acrylate | 0.077 | 5,500 | 1.000 | 5502 | 24.71 | 0.052 | 0.052 | 5520 |
| 61 | EEA | 2-Ethoxyethyl acetate | 0.077 | 5,500 | 1.000 | 5503 | 24.71 | 0.052 | 0.052 | 5517 |
| 62 | ETG | Ethoxy Triglycol (crude) | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.052 | 0.052 | 5500 |
| 63 | ETA | Ethyl Acetate | 0.119 | 5,500 | 1.090 | 5995 | 26.92 | 0.097 | 0.097 | 7504 |
| 64 | EAA | Ethyl Acetoacetate | 0.079 | 5,500 | 1.004 | 5522 | 24.79 | 0.055 | 0.055 | 5639 |
| 65 | EAL | Ethyl Alcohol (Ethanol) | 0.086 | 5,500 | 1.070 | 5885 | 26.42 | 0.067 | 0.067 | 6255 |
| 66 | ETB | Ethyl Benzene | 0.083 | 5,500 | 1.012 | 5566 | 24.99 | 0.058 | 0.058 | 5824 |
| 67 | EBT | Ethyl Butanol | 0.078 | 5,500 | 1.002 | 5513 | 24.75 | 0.053 | 0.053 | 5564 |
| 68 | EBE | Ethyl tert-butyl ether | 0.078 | 5,500 | 1.004 | 5521 | 24.79 | 0.054 | 0.054 | 5602 |
| 69 | EBR | Ethyl butyrate | 0.090 | 5,500 | 1.020 | 5610 | 25.19 | 0.064 | 0.064 | 6107 |
| 70 | ECY | Ethyl Cyclohexane | 0.083 | 5,500 | 1.010 | 5555 | 24.94 | 0.058 | 0.058 | 5796 |
| 71 | EDC | Ethylene dichloride | 0.122 | 5,500 | 1.080 | 5940 | 26.67 | 0.097 | 0.097 | 7508 |
| 72 | EGL | Ethylene Glycol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5503 |
| 73 | EMA | Ethylene Glycol Butyl Ether Acetate | 0.077 | 5,500 | 1.001 | 5506 | 24.72 | 0.053 | 0.053 | 5544 |
| 74 | EGY | Ethylene Glycol Diacetate | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5508 |
| 75 | EPE | Ethylene Glycol Phenyl Ether | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5508 |
| 76 | EEP | Ethyl-3-ethoxypropionate | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5510 |
| 77 | EHX | 2-Ethylhexanol (Octanol) | 0.076 | 5,500 | 1.000 | 5502 | 24.71 | 0.052 | 0.052 | 5514 |
| 78 | EPR | Ethyl Propionate | 0.086 | 5,500 | 1.070 | 5885 | 26.42 | 0.067 | 0.067 | 6255 |
| 79 | ETE | Ethyl Toluene | 0.080 | 5,500 | 1.006 | 5531 | 24.83 | 0.056 | 0.056 | 5679 |
| 80 | FAM | Formamide | 0.076 | 5,500 | 1.002 | 5511 | 24.74 | 0.052 | 0.052 | 5520 |
| 81 | FMS | Formaldehyde Solution | 0.076 | 5,500 | 1.003 | 5517 | 24.77 | 0.052 | 0.052 | 5517 |
| 82 | FAL | Furfuryl Alcohol | 0.077 | 5,500 | 1.001 | 5506 | 24.72 | 0.053 | 0.053 | 5526 |
| 83 | FFA | Furfural | 0.078 | 5,500 | 1.003 | 5517 | 24.77 | 0.053 | 0.053 | 5575 |
| 84 | GAK | Gasoline Blending Stocks: Alkylates | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.232 | 0.232 | 11610 |
| 85 | GRF | Gasoline Blending Stocks: Reformates | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.232 | 0.232 | 11610 |
| 86 | GAT | Gasolines: Automotive | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.232 | 0.232 | 11610 |
| 87 | GAV | Gasolines: Aviation | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.232 | 0.232 | 11610 |
| 88 | GCS | Gasolines: Casinghead | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.232 | 0.232 | 11610 |
| 89 | GPL | Gasolines: Polymer | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.232 | 0.232 | 11610 |
| 90 | GSR | Gasolines: StraightRun | 0.217 | 5,500 | 1.250 | 6875 | 30.87 | 0.232 | 0.232 | 11610 |
| 91 | GCR | Glycerine | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.052 | 0.052 | 5500 |
| 92 | HMX | Heptane (all isomers) | 0.105 | 5,500 | 1.050 | 5775 | 25.93 | 0.079 | 0.079 | 6779 |
| 93 | HEP | Heptonic Acid | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5507 |
| 94 | HTX | Heptanol (all isomers) | 0.077 | 5,500 | 1.001 | 5504 | 24.72 | 0.053 | 0.053 | 5525 |
| 95 | HPX | Heptene (all isomers) | 0.109 | 5,500 | 1.058 | 5819 | 26.13 | 0.083 | 0.083 | 8958 |
| 96 | HXS | Hexane (all isomers) | 0.142 | 5,500 | 1.140 | 6270 | 28.15 | 0.126 | 0.126 | 8561 |
| 97 | HXO | Hexaonic Acid | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5506 |
| 98 | HXN | Hexanol | 0.088 | 5,500 | 1.020 | 5610 | 25.19 | 0.063 | 0.063 | 6031 |
| 99 | HEX | Hexene (all isomers) | 0.148 | 5,500 | 1.160 | 6380 | 28.65 | 0.136 | 0.136 | 8882 |
| 100 | HXG | Hexylene Glycol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5501 |
| 101 | IPH | Isophorone | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5507 |
| 102 | JPF | Jet Fuels: JP-4 | 0.124 | 5,500 | 1.068 | 5874 | 26.37 | 0.097 | 0.097 | 7499 |
| 103 | JPV | Jet Fuels JP-5 (Kerosene, heavy) | 0.078 | 5,500 | 1.002 | 5511 | 24.74 | 0.053 | 0.053 | 5562 |
| 104 | KRS | Kerosene | 0.079 | 5,500 | 1.003 | 5517 | 24.77 | 0.054 | 0.054 | 5605 |
| 105 | MTT | Methyl Acetate | 0.122 | 5,500 | 1.122 | 6171 | 27.71 | 0.105 | 0.105 | 7812 |
| 106 | MAL | Methyl Alcohol (Methanol) | 0.079 | 5,500 | 1.133 | 6229 | 27.97 | 0.070 | 0.070 | 6355 |
| 107 | MAC | Methylamyl Acetate | 0.082 | 5,500 | 1.007 | 5536 | 24.86 | 0.057 | 0.057 | 5756 |
| 108 | MAA | Methylamyl Alcohol | 0.081 | 5,500 | 1.009 | 5547 | 24.91 | 0.057 | 0.057 | 5730 |
| 109 | MAK | Methylamyl Keytone | 0.076 | 5,500 | 1.001 | 5506 | 24.72 | 0.052 | 0.052 | 5506 |
| 110 | MAM | Methyl Acrylate | 0.115 | 5,500 | 1.082 | 5951 | 26.72 | 0.092 | 0.092 | 7303 |

| | | | | | | Pipe run #1 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Description: 8" Piping | | | | |
| | | | | | | Pipe ID: 7.98 (in) | | | | |
| | | | | | | Equivalent Length of Pipe (from Table 4a): 493.9 (feet) | | | | |
| | | | | | | Darcy friction factor: 0.014 | | | | |
| 111 | MBE | Methyl Tert-Butyl Ether (MTBE) | 0.077 | 5,500 | 1.001 | 5504 | 24.72 | 0.052 | 0.052 | 5519 |
| 112 | MBK | Methyl Butyl Ketone | 0.088 | 5,500 | 1.019 | 5607 | 25.17 | 0.062 | 0.062 | 6012 |
| 113 | MBU | Methyl Butyrate | 0.091 | 5,500 | 1.025 | 5639 | 25.32 | 0.065 | 0.065 | 6168 |
| 114 | MEK | Methyl Ethyl Ketone | 0.108 | 5,500 | 1.090 | 5995 | 26.92 | 0.088 | 0.088 | 7135 |
| 115 | MHK | Methyl Heptyl Ketone | 0.077 | 5,500 | 1.001 | 5507 | 24.73 | 0.053 | 0.053 | 5546 |
| 116 | MIK | Methyl Isobutyl Ketone | 0.089 | 5,500 | 1.023 | 5627 | 25.26 | 0.064 | 0.064 | 6096 |
| 117 | MMM | Methyl methacrylate | 0.099 | 5,500 | 1.040 | 5722 | 25.69 | 0.074 | 0.074 | 6538 |
| 118 | MNA | Methyl Naphthalene | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5508 |
| 119 | MNS | Mineral Spirits | 0.079 | 5,500 | 1.004 | 5522 | 24.79 | 0.055 | 0.055 | 5633 |
| 120 | MPL | Morpholine | 0.084 | 5,500 | 1.016 | 5588 | 25.09 | 0.059 | 0.059 | 5857 |
| 121 | MRE | Myrcene | 0.079 | 5,500 | 1.003 | 5519 | 24.78 | 0.054 | 0.054 | 5625 |
| 122 | PTN | Naphtha: Petroleum | 0.078 | 5,500 | 1.004 | 5521 | 24.79 | 0.054 | 0.054 | 5600 |
| 123 | NSV | Naphtha: Solvent | 0.078 | 5,500 | 1.004 | 5522 | 24.79 | 0.054 | 0.054 | 5607 |
| 124 | NSS | Naphtha: Stoddard Solvent | 0.079 | 5,500 | 1.004 | 5522 | 24.79 | 0.055 | 0.055 | 5633 |
| 125 | NVM | Naphtha: VM&P | 0.079 | 5,500 | 1.004 | 5521 | 24.79 | 0.054 | 0.054 | 5627 |
| 126 | NAX | Nonane (all isomers) | 0.080 | 5,500 | 1.005 | 5530 | 24.83 | 0.056 | 0.056 | 5684 |
| 127 | NON | Nonene (all isomers) | 0.082 | 5,500 | 1.007 | 5539 | 24.87 | 0.057 | 0.057 | 5733 |
| 128 | NNS | Nonyl Alcohol (all isomers) | 0.078 | 5,500 | 1.002 | 5511 | 24.74 | 0.054 | 0.054 | 5579 |
| 129 | NNP | Nonyl Phenol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5512 |
| 130 | NPM | 1-, 2-Nitropropane | 0.086 | 5,500 | 1.021 | 5618 | 25.21 | 0.062 | 0.062 | 5979 |
| 131 | OAX | Octane (all isomers) | 0.087 | 5,500 | 1.016 | 5587 | 25.09 | 0.061 | 0.061 | 5969 |
| 132 | OCX | Octanol (all isomers) | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5507 |
| 133 | OTX | Octene (all isomers) | 0.088 | 5,500 | 1.018 | 5599 | 25.14 | 0.063 | 0.063 | 6033 |
| 134 | OTW | Oil, fuel: No. 2 | 0.095 | 5,500 | 1.011 | 5562 | 24.97 | 0.066 | 0.066 | 6198 |
| 135 | OTD | Oil, fuel: No. 2-D | 0.084 | 5,500 | 1.014 | 5576 | 25.04 | 0.059 | 0.059 | 5853 |
| 136 | OFR | Oil, fuel: No. 4 | 0.078 | 5,500 | 1.003 | 5517 | 24.77 | 0.054 | 0.054 | 5577 |
| 137 | OFV | Oil, fuel: No. 5 | 0.078 | 5,500 | 1.003 | 5517 | 24.77 | 0.054 | 0.054 | 5577 |
| 138 | OSX | Oil, fuel: No. 6 | 0.078 | 5,500 | 1.003 | 5517 | 24.77 | 0.054 | 0.054 | 5577 |
| 139 | OIL | Oil, misc: Crude | 0.078 | 5,500 | 1.250 | 6875 | 30.87 | 0.083 | 0.083 | 6951 |
| 140 | ODS | Oil, Misc: Diesel | 0.084 | 5,500 | 1.014 | 5576 | 25.04 | 0.059 | 0.059 | 5854 |
| 141 | OLB | Oil, Misc: Lubricating | 0.076 | 5,500 | 1.003 | 5517 | 24.77 | 0.052 | 0.052 | 5517 |
| 142 | ORL | Oil, Misc: Residual | 0.076 | 5,500 | 1.003 | 5517 | 24.77 | 0.052 | 0.052 | 5517 |
| 143 | OTB | Oil, Misc: Turbine | 0.082 | 5,500 | 1.006 | 5533 | 24.84 | 0.057 | 0.057 | 5754 |
| 144 | PTY | Pentane (all isomers) | 0.350 | 5,500 | 1.540 | 8470 | 38.03 | 0.567 | 0.567 | 18150 |
| 145 | PTE | Pentene (all isomers) | 0.310 | 5,500 | 1.499 | 8245 | 37.02 | 0.477 | 0.477 | 16640 |
| 146 | PIN | Pinene | 0.083 | 5,500 | 1.008 | 5542 | 24.88 | 0.057 | 0.057 | 5777 |
| 147 | PLB | Polybutene | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5501 |
| 148 | PGC | Polypropylene Glycol | 0.076 | 5,500 | 1.002 | 5511 | 24.74 | 0.052 | 0.052 | 5511 |
| 149 | IAC | Propyl Acetate (iso-) | 0.097 | 5,500 | 1.036 | 5698 | 25.58 | 0.072 | 0.072 | 6447 |
| 150 | PAT | Propyl Acetate (n-) | 0.098 | 5,500 | 1.037 | 5704 | 25.61 | 0.072 | 0.072 | 6472 |
| 151 | IPA | Propyl Alcohol (iso-) | 0.091 | 5,500 | 1.060 | 5830 | 26.18 | 0.070 | 0.070 | 6382 |
| 152 | PAL | Propyl Alcohol (n-) | 0.082 | 5,500 | 1.024 | 5632 | 25.29 | 0.059 | 0.059 | 5851 |
| 153 | PBY | Propylbenzene (all isomers) | 0.079 | 5,500 | 1.004 | 5522 | 24.79 | 0.055 | 0.055 | 5628 |
| 154 | IPX | iso-Propylcyclohexane | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5507 |
| 155 | PPG | Propylene Glycol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5504 |
| 156 | PGN | Propylene Glycol Methyl Ether Acetate | 0.083 | 5,500 | 1.014 | 5577 | 25.04 | 0.058 | 0.058 | 5826 |
| 157 | PTT | Propylene Tetramer | 0.076 | 5,500 | 1.000 | 5502 | 24.71 | 0.052 | 0.052 | 5502 |
| 158 | SFL | Sulfolane | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5506 |
| 159 | STY | Styrene | 0.081 | 5,500 | 1.008 | 5544 | 24.89 | 0.056 | 0.056 | 5719 |
| 160 | TTG | Tetraethylene Glycol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5511 |
| 161 | THN | Tetrahydronaphthalene | 0.077 | 5,500 | 1.001 | 5504 | 24.72 | 0.053 | 0.053 | 5529 |
| 162 | TOL | Toluene | 0.091 | 5,500 | 1.030 | 5665 | 25.44 | 0.066 | 0.066 | 6201 |
| 163 | TCN | 1,2,3-Trichloropropane | 0.079 | 5,500 | 1.003 | 5517 | 24.77 | 0.055 | 0.055 | 5633 |
| 164 | TCP | Tricresyl Phosphate (less than 1% of ortho isomer) | 0.077 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5521 |
| 165 | TEB | Triethylbenzene | 0.077 | 5,500 | 1.000 | 5502 | 24.71 | 0.052 | 0.052 | 5518 |
| 166 | TEN | Triethylamine | 0.105 | 5,500 | 1.050 | 5775 | 25.93 | 0.079 | 0.079 | 6795 |
| 167 | TEG | Triethylene Glycol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5508 |
| 168 | TPS | Triethyl Phosphate | 0.077 | 5,500 | 1.001 | 5503 | 24.71 | 0.053 | 0.053 | 5530 |
| 169 | TRE | Trimethylbenzene (all isomers) | 0.078 | 5,500 | 1.003 | 5515 | 24.76 | 0.054 | 0.054 | 5588 |
| 170 | TRP | Trixylenyl Phosphate | 0.076 | 5,500 | 1.000 | 5500 | 24.70 | 0.052 | 0.052 | 5500 |
| 171 | THF | Tetrahydrofuran | 0.090 | 5,500 | 1.170 | 6435 | 28.89 | 0.084 | 0.084 | 7001 |
| 172 | UDC | Undecene | 0.077 | 5,500 | 1.001 | 5506 | 24.72 | 0.053 | 0.053 | 5542 |
| 173 | UND | Undecyl Alcohol | 0.076 | 5,500 | 1.000 | 5501 | 24.70 | 0.052 | 0.052 | 5509 |
| 174 | VAM | Vinyl Acetate | 0.130 | 5,500 | 1.116 | 6138 | 27.56 | 0.111 | 0.111 | 8015 |
| 175 | XLX | Xylenes (ortho-, meta-, para-) | 0.083 | 5,500 | 1.010 | 5556 | 24.95 | 0.058 | 0.058 | 5786 |
| | | | | | | | | max = | 0.567 | 18150 |

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

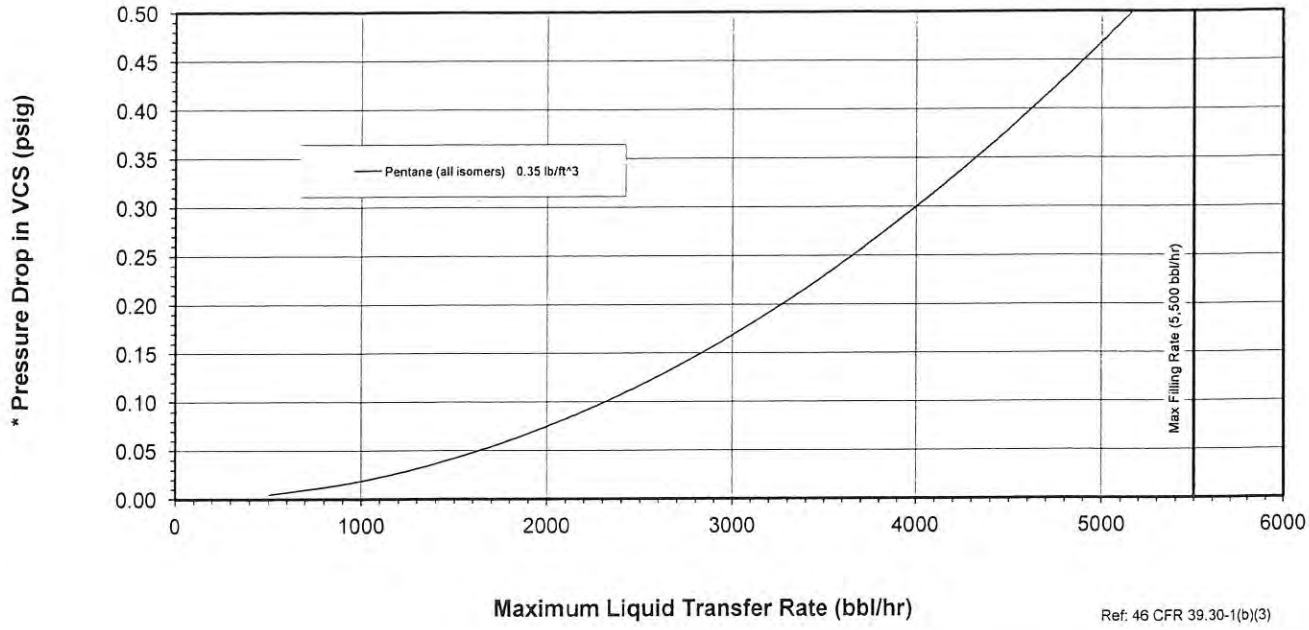
| | | | |
|---|---|---|---|
| a. High-velocity P-V Valve pressure setting: | 1.50 (psig) | | |
| b. Cargo tank P-V Valve pressure setting: | 1.50 (psig) | | |
| c. 80% of lowest P-V Valve Pressure Setting: | 1.20 (psig) | | |
| d. Highest Pressure Drop from Tank to Facility Connection: | 0.57 (psig) | for | Pentane (all isomers) |
| e. Max Allowable Back Pressure at Facility Connection: | 0.63 (psig) | | |

Conclusion:
For the cargo with the highest pressure drop (Pentane), the pressure drop is 0.57 psig. This, when added to the back pressure at the facility vapor connection must not exceed 80% of the pressure setting of any P-V valve in the cargo tank venting system. Therefore, the maximum allowable back pressure at the shore facility must not exceed 0.63 psig when loading with Pentane at the maximum liquid transfer rate (5,500 bbl/hr).

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

### Curve of Loading Rate vs. Pressure Drop

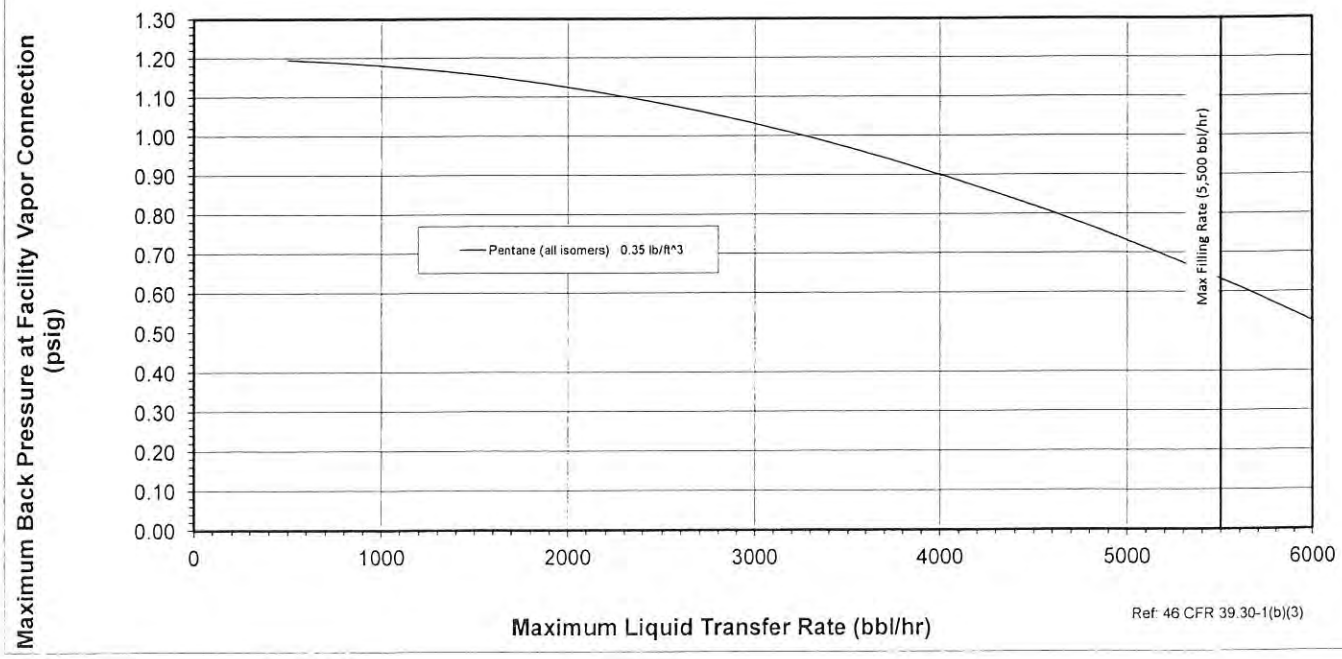
**Conrad Shipyard**
**Hulls C1007, C1008**




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

### Curve of Allowable Back Pressure at Facility Connection

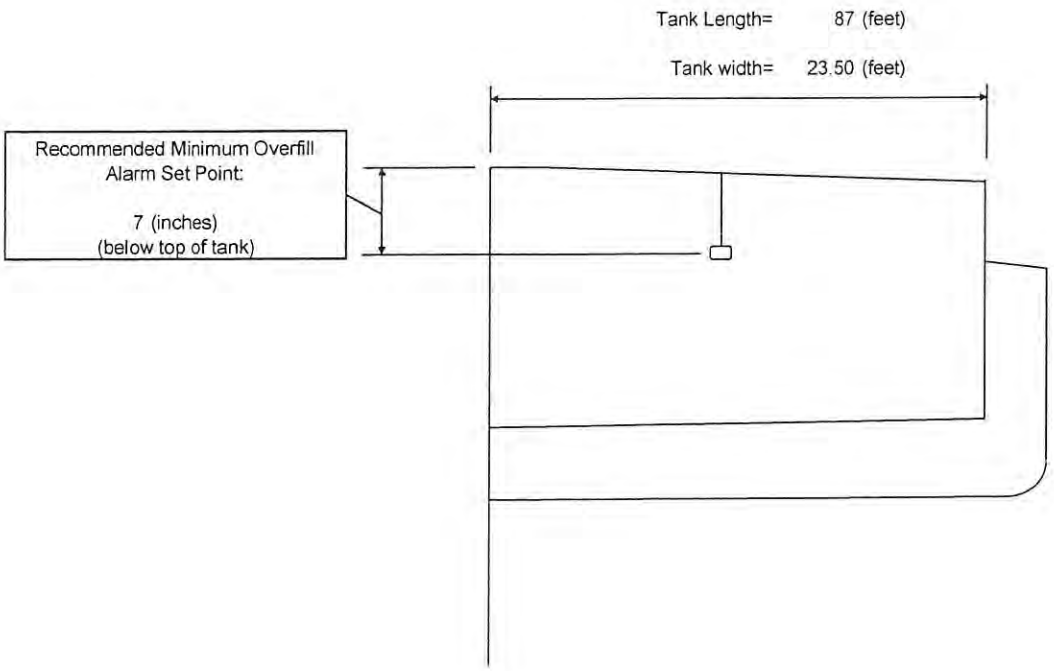
**Conrad Shipyard**
**Hulls C1007, C1008**




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

CONRAD SHIPYARD
C1007, C1008

## Calculation of Overfill Alarm Set Point
## (Cargo Tank No. 1 P/S)

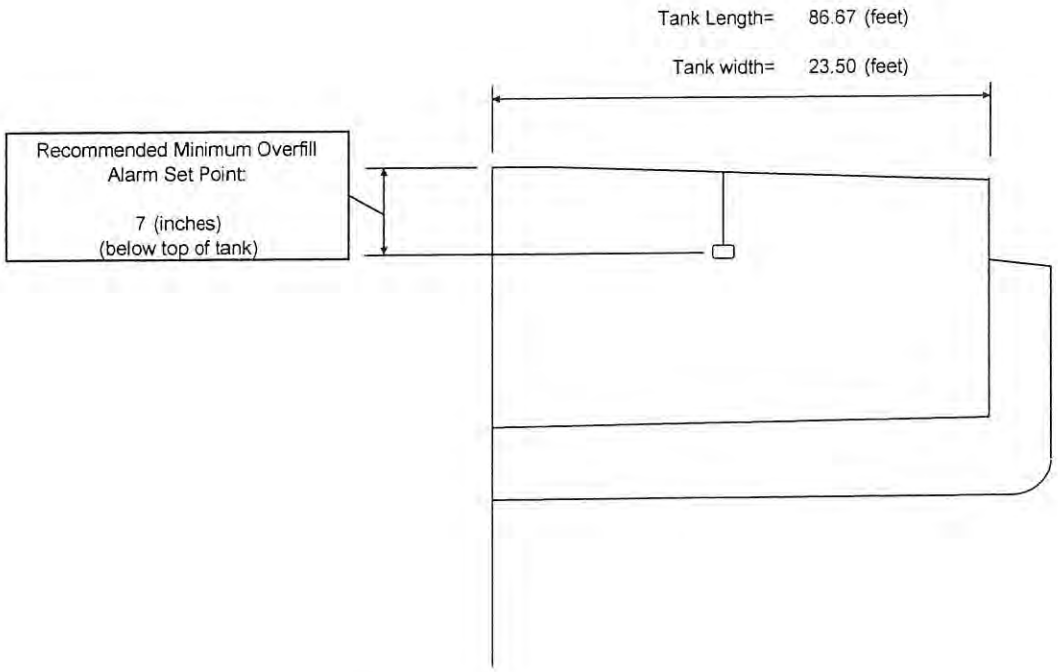



| | | | |
|---|---|---|---|
| Maximum (per tank) Cargo | = | 5,500 (bbl/hr) | |
| Loading Rate | = | 91.67 (bbl/min) | |
| Minimum allowable time from alarm to overflow | = | 60 (sec) | |
| Required volume above overfill alarm set point | = | 91.7 (bbl) | |
| Capacity to deck at CL (17'-8" ABL) = | | 5315 BBL | |
| Capacity to 7" below dk at CL (17'-1" ABL) = | | 5203 BBL | |
| Volume above alarm = | | 112.2 BBL | RESULT OK |
| **Recommended set point of | = | 7 (inches) | [Appx. 98% full tank] |

| | |
|---|---|
| **Note: Or 98.5%, whichever is lower (to comply with 33CFR155.775) | |
| Capacity at 98.5% = | 5235 BBL |
| Dist from TT at CL = | 0.49 ft. |

**CONRAD SHIPYARD**
**C1007, C1008**

**Calculation of Overfill Alarm Set Point**
**(Cargo Tank No. 2 P/S)**




| | | | |
|---|---|---|---|
| Maximum (per tank) Cargo Loading Rate | = | 5,500 (bbl/hr)<br>91.67 (bbl/min) | |
| Minimum allowable time from alarm to overflow | = | 60 (sec) | |
| Required volume above overfill alarm set point | = | 91.7 (bbl) | |
| Capacity to deck at CL (17'-8" ABL) = | | 5295 BBL | |
| Capacity to 7" below dk at CL (17'-1" ABL) = | | 5183 BBL | |
| Volume above alarm = | | 111.8 BBL | RESULT OK |
| **Recommended set point of | = | 7 (inches) | [Appx. 98% full tank] |

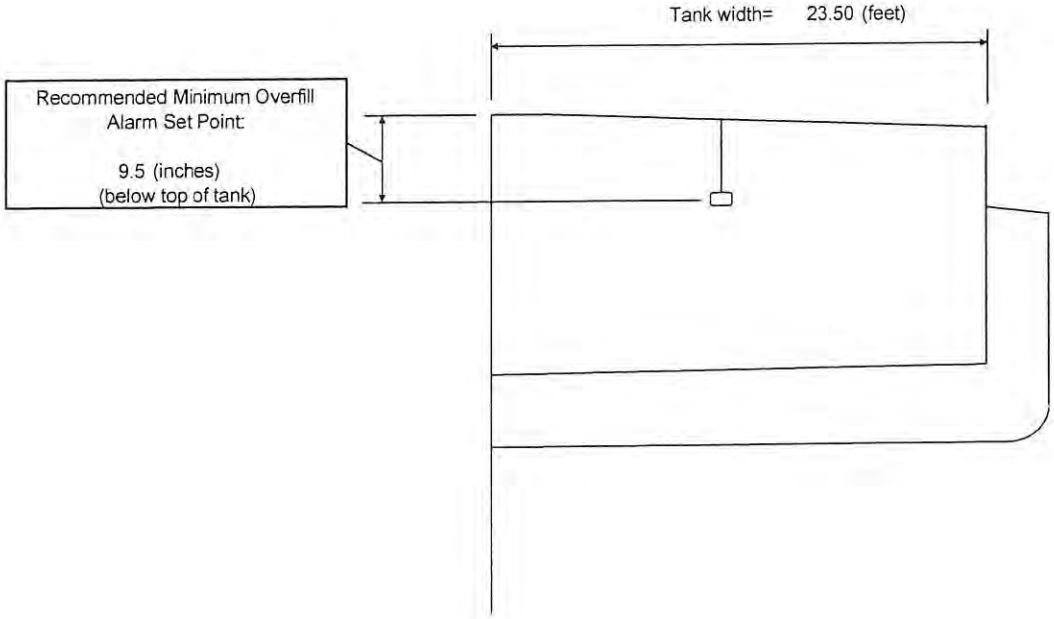
| | |
|---|---|
| **Note: Or 98.5%, whichever is lower (to comply with 33CFR155.775) | |
| Capacity at 98.5% = | 5215 BBL |
| Dist from TT at CL = | 0.49 ft. |

**CONRAD SHIPYARD**
**C1007, C1008**

## Calculation of Overfill Alarm Set Point
**(Cargo Tank No. 3 P/S)**

Tank Length= 86.33 (feet)
Trunk Length= 46.33 (feet)

Tank width= 23.50 (feet)




| | | | |
|---|---|---|---|
| Maximum (per tank) Cargo Loading Rate | = | 5,500 (bbl/hr)<br>91.67 (bbl/min) | |
| Minimum allowable time from alarm to overflow | = | 60 (sec) | |
| Required volume above overfill alarm set point | = | 91.7 (bbl) | |
| Capacity to deck at CL (17'-8" ABL) = | | 4427 BBL | |
| Capacity to 9.5" below dk at CL (16'-10.5" ABL) = | | 4328 BBL | |
| Volume above alarm = | | 99.5 BBL | RESULT OK |
| **Recommended set point of | = | 9.5 (inches) | [Appx. 98% full tank] |

| | |
|---|---|
| **Note: Or 98.5%, whichever is lower (to comply with 33CFR155.775) | |
| Capacity at 98.5% = | 4361 BBL |
| Dist from TT at CL = | 0.62 ft. |

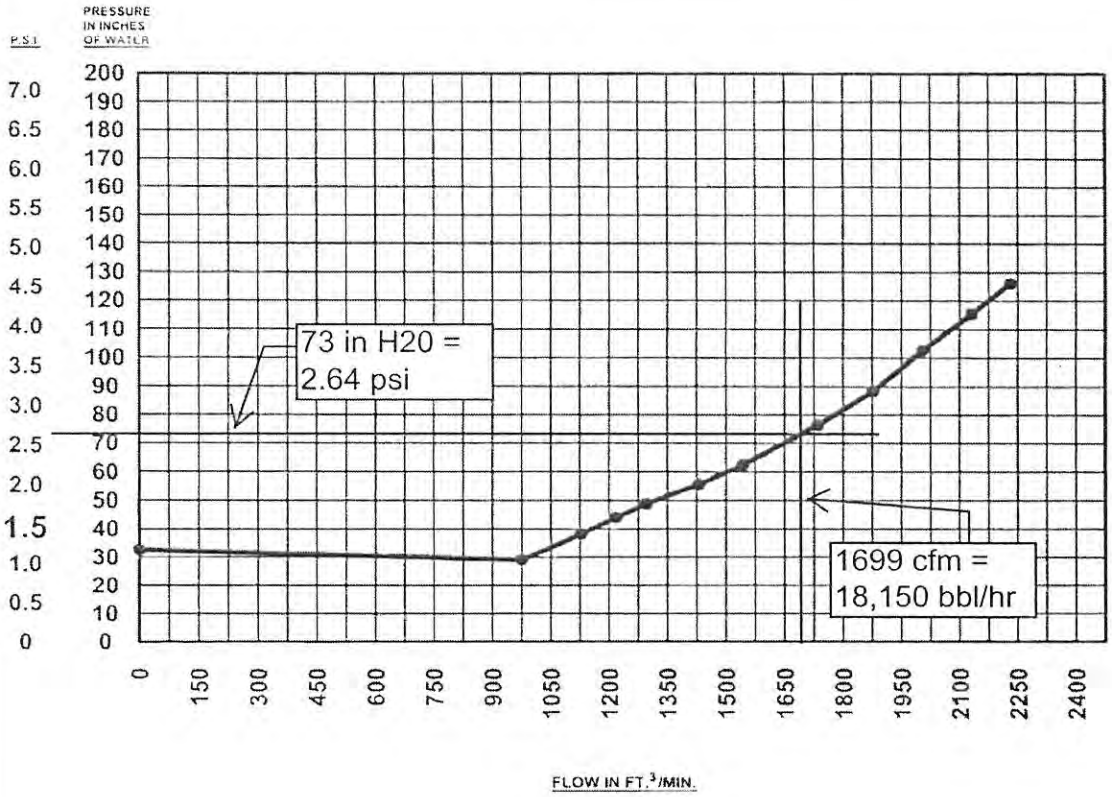
## REFERENCES

1. 46 CFR 32.55-25, Venting of cargo tanks of tank barges constructed on or after July 1, 1951 - B/ALL
2. 46 CFR 39.20-11, Vapor overpressure and vacuum protection - TB/ALL
3. 46 CFR 39.30-1, Operational Requirements - TB/ALL
4. Flow of Fluids Through Valves, Fittings, and Pipe; Crane Technical Paper No. 410
5. USCG Guidelines for Determining the Maximum Liquid Transfer Rate for a Tank Vessel Transferring a Flammable or Combustible Cargo Using a Vapor Control System
6. Conrad Dwg. P3 Vapor Control Piping
7. USCG CHRIS (Chemical Hazards Response Information System) Manual.
8. 46 CFR 39.20-9, Tank Barge Liquid Overfill Protection - B/ALL
9. Cameron Hydraulic Data, 15th edition

## LIST OF ATTACHMENTS

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

# CONRAD C1007, C1008



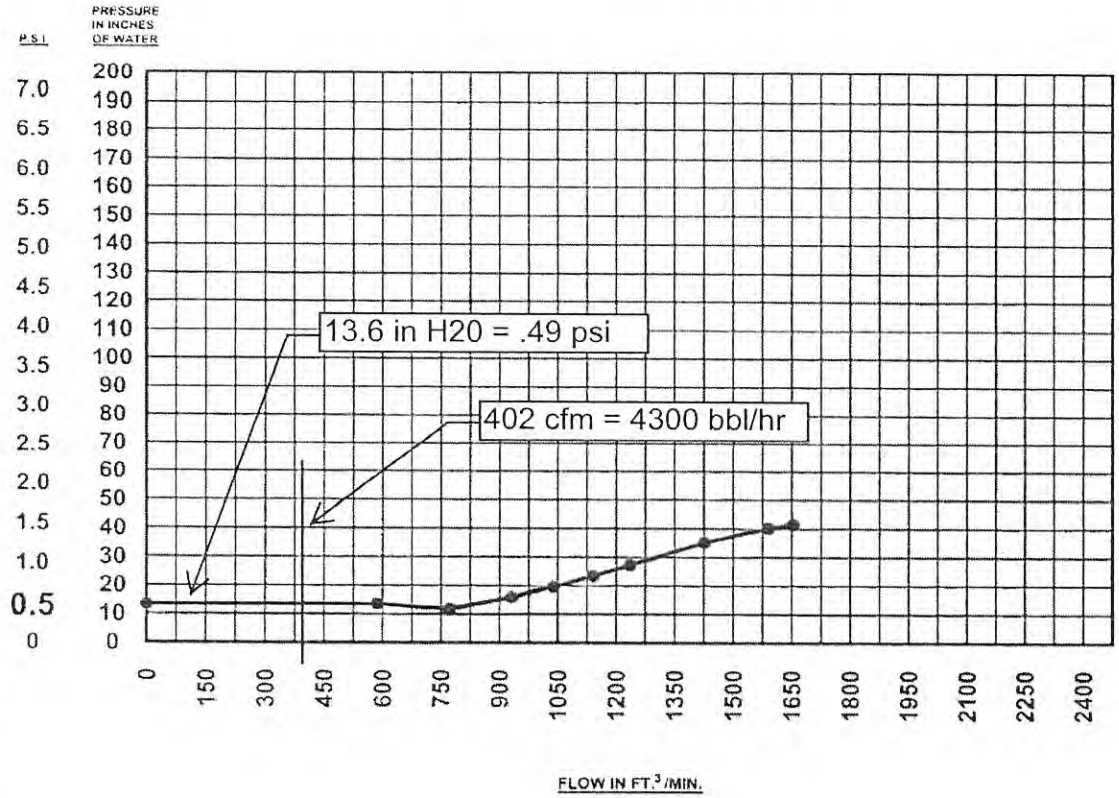

| BARRELS PER HOUR | FLOW FT.³/ MIN. | PRESSURE IN. OF $H_2O$ |
|---|---|---|
| 10418 | 974 | 29.2 |
| 12054 | 1127 | 38.6 |
| 13017 | 1217 | 44.2 |
| 13862 | 1296 | 49.0 |
| 15295 | 1430 | 55.8 |
| 16493 | 1542 | 62.6 |
| 18547 | 1734 | 76.6 |
| 20066 | 1876 | 88.5 |
| 21435 | 2004 | 102.8 |
| 22783 | 2130 | 115.8 |
| 23852 | 2230 | 126.3 |

**Curve for Pressure Side**
**6" PV Valve - 1.5 PSI**
data based on air flow

ELECTROMECHANICAL RESEARCH LABORATORIES, INC.
P.O. BOX 1028, NEW ALBANY, IN 47151

| DATE | DRAWN | PART NAME |
|---|---|---|
| 5/5/03 | D. URBAN | Flow Curve, 1.5 PSI, Pressure |
| TOLERANCE: 0.0 = +/- 0.030, 0.00 = +/- 0.015, 0.000 = +/- 0.005 | APPROVED | UNIT NAME: Marine 6" PV (MD II) |
| | SCALE / JOB NO. | DWG. NO.: 125O125B / ITEM NO. |

# CONRAD C1007, C1008




| BARRELS PER HOUR | FLOW FT.$^3$/ MIN. | PRESSURE IN. OF $H_2O$ |
|---|---|---|
| 6260 | 585 | 13.6 |
| 8256 | 772 | 11.8 |
| 9958 | 931 | 16.0 |
| 11100 | 1038 | 19.9 |
| 12197 | 1141 | 23.7 |
| 13207 | 1235 | 27.5 |
| 15252 | 1426 | 35.5 |
| 17003 | 1590 | 40.4 |
| 17674 | 1653 | 41.7 |

**Curve for Vacuum Side**
**6" PV Valve - 0.5 PSI**
**data based on air flow**

ELECTROMECHANICAL RESEARCH LABORATORIES, INC.
P.O. BOX 1026, NEW ALBANY, IN 47151

| | | | |
|---|---|---|---|
| DATE: 11/28/01 | DRAWN: D. URBAN | PART NAME: Flow Curve, 0.5 PSI, Vacuum | |
| TOLERANCE: 0.0 = +/- 0.030, 0.00 = +/- 0.015, 0.000 = +/- 0.005 | APPROVED | UNIT NAME: Marine 6" PV (MD II) | |
| | SCALE / JOB NO. | DWG. NO.: 332M075B | ITEM NO. |

# U. S. Department of Homeland Security
## United States Coast Guard
# Certificate of Approval

Coast Guard Approval Number: 162.017/167/4 Expires: 05 April 2016

PRESSURE-VACUUM RELIEF VALVES FOR TANK VESSELS

ELECTROMECHANICAL RESEARCH
LABORATORIES INC.
2560 Charlestown Road
NEW ALBANY IN 471510

ERL SUPERAC Model II, 6-inch High Velocity Pressure/Vacuum Relief Valve.

High-velocity weight-loaded pressure/vacuum relief valve, constructed of 300 series stainless steel.

Identifying Data: ERL Drawing No. 050M147B dated June 6, 2001. Flow data located in CEESI Test Reports dated December 12, 2001 (initial testing), November 8, 2004 (5.5 psi pressure setting), December 13, 2005 (10.0 psi pressure setting), and January 30, 2006 (3.0 psi vacuum setting), February 14, 2011 (5.0 psi vacuum setting).

Approved for relief settings of: 1.0 - 10.0 psig pressure, and 0.5 - 5.0 psig vacuum.

ERL SUPERAC (TM) Model II 6" P/V Valve has been tested in accordance with API 2000, and is approved for use in vapor control systems.

This certificate supersedes approval no. 162.017/0167/3 dated May 12, 2006, to expand range of vacuum settings up to 5.0 psi.

*** END ***

THIS IS TO CERTIFY THAT the above named manufacturer has submitted to the undersigned satisfactory evidence that the item specified herein complies with the applicable laws and regulations as outlined on the reverse side of this Certificate, and approval is hereby given. This approval shall be in effect until the expiration date hereon unless sooner canceled or suspended by proper authority.

GIVEN UNDER MY HAND THIS 5th DAY OF APRIL 2011, AT WASHINGTON D.C.

C. R. O'NEIL
Assistant Chief, Tank Vessel and Offshore Division
U.S. Coast Guard Marine Safety Center

DEPT. OF HOMELAND SECURITY, USCG, CGHQ-10030
(REV. 3-03)

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

| | | | |
|---|---|---|---|
| **Vessel Name** | CBC 374, 375, 380, 384, 386 | **Shipyard** | Conrad and Orange |
| **Official Number** | various | **Hull Number** | C-1007, C-1008, H-451 through H-453 |

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

**2. Tank Maximum Design Working Pressure** 3.00 psig — **Raised Trunk** [X] **Flush Deck** [ ]

**3. Authorized Maximum Cargo Transfer Rate(s)** 5,500 bbl/hr loading (max 2 tanks simultaneously); 4,300 bbl/hr discharging

**4. Authorized Maximum Vapor-Air Mixture Density** 0.347 $lbm/ft^3$

**5. Authorized VCS Categories** 1 through 7

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

a. Cargo Name ISO-PENTANE

b. Cargo Name ISO-PENTANE

**7. Pressure Vacuum Valve:**

| | |
|---|---|
| Manufacturer | ERL |
| Size | SUPERAC II PV-6 |
| CG Approval | 162.017/167/4 |

**Settings in psig:**

| | |
|---|---|
| Pressure-side | 1.5 |
| Vacuum-side | 0.5 |

**8. VCS Pipe Sizes:** Approx. Inside Diameter

| | |
|---|---|
| Longitudinal Header (inches) | 8 |
| Transverse Header (Inches) | 8 |

| | | |
|---|---|---|
| **Required Venting Capacity of Pressure-Side of P/V valve** | 14673 | bbl/hr (air) |
| **Required Venting Capacity of Vacuum-Side of P/V valve** | 5500 | bbl/hr (air) |

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

| | | | | | |
|---|---|---|---|---|---|
| a. High Level/Tank Overfill Alarm | [X] | Type | Beran Gaurd 07324TWIN-2AI | | |
| b. Overfill Control Shutdown | [X] | Type | OCMI to Verify | | |
| c. Spill Valve | [ ] | Type | N/A | Meets ASTM F1271 | **Setting in psig** N/A |
| d. Rupture Disk | [ ] | Type | N/A | | |

**10. Closed Gauging** Verify the vessel has closed gauging that satisfies 46 CFR 39.20-3 and 151.15-10(c).

**11. Instructions/Guidelines for the OCMI:**

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

In accordance with 46 CFR Part 39, excluding part 39.40, this vessel's vapor collection system has been inspected to the plans approved by Marine Safety Center letter Serial No. C1-1205189 dated January 4, 2013, and has been found acceptable for the collection of bulk liquid cargo vapors annotated with "Yes" in the the vessel's Cargo Authority Attachment's VCS column.

When the vessel is carrying cargoes containing greater than 0.5% benzene, the person in charge is responsible for ensuring the provisions of 46 US Code of Federal Regulations Part 197, Subpart C are applied.

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

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

11d. Previous applicable approval letters:

| | | | |
|---|---|---|---|
| VCS Approval Letter | MSC letter C1-1205189 dated January 4, 2013 | MSC Plan Reviewer | LT D. T. Whitley |