

U.S. Department of  
Homeland Security

United States  
Coast Guard



Commanding Officer  
United States Coast Guard  
Marine Safety Center

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16710/P018437  
Serial: C1-1303087  
September 12, 2013

Conrad Industries, Inc  
Attn: Mr. Richard Soudelier  
P.O. Box 790  
Morgan City, LA 70381  
Email: RLSoudelier@conradindustries.com

Subj: CBR 2021, O.N. 1248194, Conrad Shipyard Hull No. C-1032  
CBR 2022, O.N. 1248783, Conrad Shipyard Hull No. C-1033  
HSM 1001, O.N. 1249240, Conrad Shipyard Hull No. C-1035  
HSM 1002, O.N. 1249241, Conrad Shipyard Hull No. C-1036  
CBC 388, O.N. 1248751, Conrad Shipyard Hull No. C-1040  
CBC 389, O.N. 1248047, Conrad Shipyard Hull No. C-1041  
NEW CONSTRUCTION, CG1249506, Conrad Shipyard Hull No. C-1042  
NEW CONSTRUCTION, CG1249510, Conrad Shipyard Hull No. C-1044  
297'-6" x 54' x 12' Unmanned Double Hull Type II/III Tank Barges (D/O)  
Grade A (max. 25 psia Reid) and Lower Grades Flammable or Combustible Liquids  
Identified in 46 CFR Table 30.25-1 or 46 CFR 153 Table 2, and Specified Hazardous  
Cargoes  
Rivers; Lakes, Bays, and Sounds; Limited Coastwise on unmanned fair weather voyages  
only, not more than 12 miles offshore between St. Marks and Carrabelle, Florida  
Plan Approval Extension: Vapor Collection System and List of Authorized Cargoes

Dear Mr. Soudelier:

We have reviewed the information submitted with your e-mail dated August 22, 2013 (MSC Document No. 1315809), wherein you have requested that plans previously approved under project P014938 Conrad Shipyard Hulls C-994 through C-997, be used for the construction of the subject vessels. While we have no objection to you using the plans that were previously approved plans, please be advised that the cognizant Officer in Charge, Marine Inspection (OCMI) has the final authority for these issues.

Enclosure (1) includes details regarding MSC approval letters for previously approved plans you wish to use for the construction of the subject vessels. By copy of this letter, we recommend the OCMI extend approval of all drawings and calculations addressed in enclosure (1) to the subject vessels. This extension of plan approval is based on our understanding that:

- a. The subject vessel will be built to the same plans as those specified in enclosure (1),
- b. The regulations used for the original plan approval have not changed since the original plan approval,

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Subj: Conrad Shipyard Hulls C-1032, C-1033, C-1035, C-1036, C-1040, C-1041, C-1042, and C-1044

Plan Approval Extension: Vapor Collection System and List of Authorized Cargoes

- c. The owner of the original plans specifically authorizes the use of the plans for new construction,
- d. There are no modifications to subject vessel or any of the installed systems which would require additional review, and
- e. All comments provided in the original approval letters, accompanying the approved plans, still apply.

You must provide the OCMI a copy of each item listed in enclosure (1) with its corresponding MSC approval letter. Plans that do not conform to any part of (a) through (e) above shall be submitted to our office for approval. The installation, workmanship, and testing shall be to the satisfaction of the OCMI. Any vessel system, arrangement, structure, or other item that requires plan approval but is not covered by an extension must be either submitted to the MSC for review or reviewed by the OCMI.

The Vapor Control System (VCS) PRIS for the subject vessels is included as enclosure (2). In addition, we have updated each vessel's cargo and vapor control authority. The 46 CFR 151 Cargo List and VCS List of Cargoes are included as enclosures (3) and (4).

At the time of this review, some of the vessels' official numbers were not available. Once you provide the vessel names and official numbers to this office, the updated Cargo Authority Attachments (CAAs), containing the cargoes found in enclosure (3) and vapor control authority for the cargoes found in enclosure (4), will be made available for issuance by the OCMI.

Please note that only the local OCMI can issue a vessel's CAA as part of the Certificate of Inspection (COI). The OCMI will verify the carriage authority and vapor control tank group characteristics we used as a basis for creating enclosures (3) and (4) are consistent with the vessel's actual design. For the OCMI's convenience, we have included the following recommended COI endorsement:

Only those hazardous cargoes named in the vessel's Cargo Authority Attachment, Serial No. C1-1303087 dated September 12, 2013, may be carried and then only in the tanks indicated.

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.

In accordance with 46 CFR Part 39, excluding part 39.40, this vessel's vapor control system has been inspected to the plans approved by Marine Safety Center letters Serial No. C1-1204161 dated September 25, 2013 and extended by C1-

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Subj: Conrad Shipyard Hulls C-1032, C-1033, C-1035, C-1036, C-1040, C-1041, C-1042, and C-1044

Plan Approval Extension: Vapor Collection System and List of Authorized Cargoes

1303087 dated September 12, 2013 and found acceptable for collection of bulk liquid cargo vapors annotated with "Yes" in the CAA's VCS column.

Our Project Number for these vessels is **P018437**. Please ensure that future correspondence includes the Project Number, and either the Coast Guard (CG) number that appears in the subject line or the Official Number of each barge once assigned. To avoid confusion, the owners are encouraged to provide the National Vessel Documentation Center with the vessel CG numbers when applying for documentation.

If you have any questions concerning our review, please contact Lieutenant Rachel Beckmann at the number listed above.

Sincerely,



M. J. SEXTON  
Lieutenant, U. S. Coast Guard  
Assistant Chief, Tank Vessel and Offshore Division  
By direction

- Encl: (1) Plan Approval Extension Form, dated August 21, 2013  
(2) VCS PRIS, Conrad Shipyard Hulls C-1032, C-1033, C-1035, C-1036, C-1040, C-1041, C-1042, and C-1044, dated September 12, 2013  
(3) 46 CFR Part 151 Cargo List, Conrad Shipyard Hulls C-1032, C-1033, C-1035, C-1036, C-1040, C-1041, C-1042, and C-1044, dated September 12, 2013  
(4) VCS List of Cargoes, Conrad Shipyard Hulls C-1032, C-1033, C-1035, C-1036, C-1040, C-1041, C-1042, and C-1044, dated September 12, 2013

Copy: Commander, Coast Guard Sector Marine Safety Unit, Morgan City

U.S. Department of  
Homeland Security

United States  
Coast Guard



Commanding Officer  
United States Coast Guard  
Marine Safety Center

2100 2<sup>nd</sup> Street, S.W. Stop 7102  
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16710/P014938  
Serial: C1-1204161  
September 25, 2012

Conrad Industries, Inc.  
Attn: Mr. Richard L. Soudelier  
PO Box 790  
Morgan City, LA 70381  
Email: rlsoudelier@conradindustries.com

Subj: JARED JOSEPH, O.N. 1242310, Conrad Shipyard Hull No. C-994  
NICHOLAS RAY, O.N. 1213431, Conrad Shipyard Hull No. C-995  
ALLISON JANE, O.N. 1213432, Conrad Shipyard Hull No. C-996  
MACI BRYAN, O.N. 1242740, Conrad Shipyard Hull No. C-997  
297'-6" x 54' x 12' Unmanned Double Hull Type II/III Tank Barges (D/O)  
Grade A (max. 25 psia Reid) and Lower Grades Flammable or Combustible Liquids  
Identified in 46 CFR Table 30.25-1 or 46 CFR 153 Table 2 as Pollution Category I or  
III and Specified Hazardous Cargoes  
Design Density 8.7 lbs/gal; Maximum Density (slack load) 15 lbs/gal  
Rivers; Lakes, Bays, and Sounds; Limited Coastwise on unmanned fair weather voyages  
only, not more than 12 miles offshore between St. Marks and Carrabelle, Florida  
Vapor Collection System and List of Authorized Cargoes

Ref: (a) Document No. 1216407, Conrad Shipyard, "Vapor Control Piping," Dwg. No. P-03,  
Sheets 1 and 2, Rev. 2, dated May 3, 2012  
(b) Document No. 1216410, Guarino & Cox, LLC, "Vapor Control System  
Calculations," Dwg. No. C-32, Rev. 1, dated September 25, 2012  
(c) Coast Guard Marine Safety Center's "Industry Guidelines for Determining the  
Maximum Liquid Transfer Rate for a Tank Vessel Transferring a Flammable or  
Combustible Cargo Using a Vapor Control System" dated July 15, 2001

Dear Mr. Richard L. Soudelier:

In response to your electronic submissions dated September 14, 2012, September 24 2012, and September 25, 2012 we have reviewed the vapor collection system (VCS) piping plan and the vapor control pressure drop calculations for compliance with 46 CFR Part 39, excluding Subpart 39.40. The VCS piping plan, reference (a), is marked "**Approved.**" The installation, workmanship and testing shall be to the satisfaction of the cognizant Officer in Charge, Marine Inspection (OCMI). The pressure drop calculations, reference (b) are "**Examined.**" Calculations and plans such as these are not normally marked approved, but are used to verify that the system meets the applicable regulations. The following comments apply:

Subj: Conrad Shipyard Hull C-994 through C-997;  
Vapor Collection System and List of Authorized Cargoes

1. Based on your calculations, this VCS is capable of recovering vapors of the cargoes listed in enclosure (1) at a maximum vapor-air mixture density of **0.35 lbm/ft<sup>3</sup>**, at a maximum liquid load rate of **5,500 bbl/hr**, and at a maximum liquid discharge rate of **4,300 bbl/hr**.

2. In accordance with reference (b), the set-point of the overfill shutdown system shall be no higher than **7 inches** below the tank top of cargo tank 1 P/S and 2 P/S, and set no higher than **9.5 inches** below the tank top of cargo tank 3 P/S.

3. The oil transfer procedures shall include a table or graph showing the liquid transfer rate versus the pressure drop, as required by 46 CFR 39.30-1(b)(3), to the satisfaction of the cognizant OCMI. This information must be taken from the calculations, tables, and graphs contained within reference (b). However, the table or graph added to the oil transfer procedures should exclude unauthorized cargoes, and shall not reflect transfer rates exceeding the maximum liquid load rate approved in paragraph 1.

4. The tanks share a common vent header, which would allow mixing of various vapors and liquid cargoes. Note this configuration restricts the types of cargoes that can be carried simultaneously.

5. Enclosure (3) contains VCS Category 2 and 4. Polymerization and residue build-up of these cargoes can adversely affect the operation of the vapor collection system. The barge's owner must develop a method for internal visual inspection to verify that fouling of VCS components is not occurring, to the satisfaction of the cognizant OCMI.

6. In conjunction with this review, we have generated the subject vessel's cargo authority based on the Tank Group Characteristics Loading Form submitted with your email dated September 14, 2012. The 46 CFR 151 Cargo List is attached as enclosure (2).

7. The Cargo Authority Attachment (CAA) for each vessel is now available in the Coast Guard's Marine Information for Safety and Law Enforcement (MISLE). The CAA will contain the cargoes found in enclosures (1) and (2). Please note that only the cognizant OCMI can issue a vessel's CAA, which is valid only when referenced by and attached to a valid Certificate of Inspection (COI). The OCMI will verify the carriage authority and vapor control tank group characteristics we used to create enclosures (1) and (2) are consistent with the vessel's actual construction. Enclosure (3) contains the VCS tank group characteristics and our recommended COI endorsement.

As a condition of your participation in MSC's electronic commerce program, you must provide a copy of the approved drawings to the OCMI, along with a copy of the corresponding MSC approval letter.

Our Project Number for this vessel is **P014938**. Please ensure that future correspondence includes the Project Number and Official Number that appears in the subject line for each barge.

16710/P014938  
Serial: C1-1204161  
September 25, 2012

Subj: Conrad Shipyard Hull C-994 through C-997;  
Vapor Collection System and List of Authorized Cargoes

If you have any questions concerning our review, please contact Lieutenant Rachel Beckmann at the number listed above.

Sincerely,



J.B. Wheeler  
Lieutenant, U. S. Coast Guard  
Assistant Chief, Tank Vessel and Offshore Division  
By direction

Encl: (1) Vapor Collection System List of Cargoes; Conrad Shipyard Hull Nos. C-994 through C-997; dated September 25, 2012  
(2) 46 CFR Part 151 Cargo List, Conrad Shipyard Hull Nos. C-994 through C-997; dated September 25, 2012  
(3) VCS PRIS; Conrad Shipyard Hull Nos. C-994 through C-997; dated September 25, 2012

Copy: Commander, Coast Guard Sector Morgan City, w/ enclosures

[illegible]

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**I. VAPOR CONTROL SYSTEM CALCULATIONS - SUMMARY**

**A. General Description of Vessel:**

|                                       |                                    |                        |
|---------------------------------------|------------------------------------|------------------------|
| Builder:                              | CONRAD INDUSTRIES, INC             |                        |
| Builder's hull numbers:               | Conrad <del>C-994</del> THRU C-997 |                        |
| Year Built:                           | 2012 / 2013                        |                        |
| Official Numbers:                     |                                    |                        |
| Owner:                                |                                    |                        |
| Vessel Names:                         |                                    |                        |
| 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 <sup>3</sup> ) |
| Maximum Vapor Growth Rate:            | 1.54 (Pentane, all isomers)        | (lbm/ft <sup>3</sup> ) |

**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:                  | Tanktech/Bergan KLPH-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:**

|                   |                                                                    |        |
|-------------------|--------------------------------------------------------------------|--------|
|                   | <b>(One central P/V valve only, no individual tank P-V valves)</b> |        |
| 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 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.

#### **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 cargoes), 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 0.24 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 (1.03 psig) does not exceed 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 &amp; Vapor Growth Rate

|    | CHRIS<br>Code | Name                                                    | VCS<br>Category | Liquid<br>S.G. | *Vapor<br>Press. @<br>115 F<br>(psia) | Vapor<br>S.G. | Vapor-air<br>Mixture<br>Weight<br>Density<br>(lb/ft <sup>3</sup> ) | Vapor<br>Growth<br>Rate | Max.<br>Loading<br>Rate | Vapor<br>Volumetric<br>Flow Rate<br>(bbl/hr) | Air<br>Equivalent<br>Volumetric<br>Flow Rate<br>(bbl/hr) | Pressure<br>Drop to<br>PV Valve<br>in VCS<br>(See<br>Table 3)<br>(psig) | Pressure<br>Drop to<br>Facility<br>Connection<br>in VCS (See<br>Table 5)<br>(psig) |
|----|---------------|---------------------------------------------------------|-----------------|----------------|---------------------------------------|---------------|--------------------------------------------------------------------|-------------------------|-------------------------|----------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| 1  | ACN           | Acrylonitrile                                           | 4               | 0.81           | 5.00                                  | 1.80          | 0.095                                                              | 1.10                    | 5,500                   | 6050                                         | 6756                                                     | 0.033                                                                   | 0.068                                                                              |
| 2  | ACT           | Acetone                                                 | 1               | 0.79           | 10.00                                 | 2.00          | 0.123                                                              | 1.20                    | 5,500                   | 6600                                         | 8393                                                     | 0.062                                                                   | 0.102                                                                              |
| 3  | ACP           | Acetophenone                                            | 1               | 1.03           | 0.80                                  | 4.14          | 0.085                                                              | 1.01                    | 5,500                   | 5588                                         | 5881                                                     | 0.025                                                                   | 0.050                                                                              |
| 4  | AND           | Adiponitrile                                            | 1               | 0.95           | 0.01                                  | 3.73          | 0.078                                                              | 1.00                    | 5,500                   | 5601                                         | 5606                                                     | 0.022                                                                   | 0.044                                                                              |
| 5  | AEC           | Amyl acetate (all isomers)                              | 1               | 0.88           | 0.33                                  | 0.10          | 0.075                                                              | 1.01                    | 5,500                   | 5636                                         | 5485                                                     | 0.022                                                                   | 0.044                                                                              |
| 6  | AAI           | Amyl Alcohol (iso-, n-, sec-, primary)                  | 1               | 0.82           | 0.30                                  | 3.04          | 0.079                                                              | 1.01                    | 5,500                   | 5533                                         | 5637                                                     | 0.023                                                                   | 0.046                                                                              |
| 7  | ATN           | Acetonitrile                                            | 3               | 0.78           | 0.03                                  | 1.41          | 0.078                                                              | 1.00                    | 5,500                   | 5503                                         | 5605                                                     | 0.022                                                                   | 0.044                                                                              |
| 8  | BAL           | Benzyl Alcohol                                          | 1               | 1.05           | 0.10                                  | 3.73          | 0.077                                                              | 1.00                    | 5,500                   | 5511                                         | 5557                                                     | 0.023                                                                   | 0.045                                                                              |
| 9  | BNZ           | Benzene                                                 | 1               | 0.88           | 4.50                                  | 2.80          | 0.114                                                              | 1.25                    | 5,500                   | 6875                                         | 8420                                                     | 0.052                                                                   | 0.103                                                                              |
| 10 | BTX           | Benzene, Toluene, Xylene mixtures (10% Benzene or more) | 1               | 0.84           | 7.30                                  | 2.80          | 0.138                                                              | 1.25                    | 5,500                   | 6875                                         | 9252                                                     | 0.083                                                                   | 0.124                                                                              |
| 11 | BAR           | Butyl Acrylate (iso-, n-)                               | 2               | 0.90           | 0.60                                  | 4.42          | 0.086                                                              | 1.01                    | 5,500                   | 5566                                         | 5908                                                     | 0.028                                                                   | 0.051                                                                              |
| 12 | BAX           | Butyl Acetate (all isomers)                             | 1               | 0.87           | 0.80                                  | 4.00          | 0.085                                                              | 1.01                    | 5,500                   | 5566                                         | 5867                                                     | 0.025                                                                   | 0.050                                                                              |
| 13 | IAL           | Butyl Alcohol (iso-)                                    | 1               | 0.81           | 0.90                                  | 2.60          | 0.083                                                              | 1.02                    | 5,500                   | 5599                                         | 5843                                                     | 0.026                                                                   | 0.050                                                                              |
| 14 | BAN           | Butyl Alcohol (n-)                                      | 1               | 0.81           | 0.50                                  | 0.10          | 0.074                                                              | 1.01                    | 5,500                   | 5555                                         | 5477                                                     | 0.022                                                                   | 0.044                                                                              |
| 15 | BAS           | Butyl Alcohol (sec-)                                    | 1               | 0.81           | 1.30                                  | 2.60          | 0.086                                                              | 1.03                    | 5,500                   | 5843                                         | 5994                                                     | 0.028                                                                   | 0.052                                                                              |
| 16 | BAT           | Butyl Alcohol (tert-)                                   | 1               | 0.78           | 2.80                                  | 2.60          | 0.097                                                              | 1.06                    | 5,500                   | 5808                                         | 6582                                                     | 0.032                                                                   | 0.063                                                                              |
| 17 | BPH           | Butyl Benzyl Phthalate                                  | 1               | 1.12           | 0.01                                  | 10.80         | 0.077                                                              | 1.00                    | 5,500                   | 5501                                         | 5518                                                     | 0.022                                                                   | 0.044                                                                              |
| 18 | BAD           | iso-Butyraldehyde                                       | 1               | 0.80           | 7.80                                  | 2.50          | 0.131                                                              | 1.18                    | 5,500                   | 6358                                         | 8344                                                     | 0.081                                                                   | 0.101                                                                              |
| 19 | BTR           | n-Butyraldehyde                                         | 1               | 0.80           | 7.80                                  | 2.50          | 0.131                                                              | 1.16                    | 5,500                   | 6358                                         | 8344                                                     | 0.081                                                                   | 0.101                                                                              |
| 20 | BUE           | Butyl Toluene                                           | 1               | 0.85           | 0.10                                  | 5.11          | 0.078                                                              | 1.00                    | 5,500                   | 5511                                         | 5680                                                     | 0.023                                                                   | 0.045                                                                              |
| 21 | CLS           | Caprolactam Solutions                                   | 1               | 1.02           | 0.05                                  | 3.90          | 0.077                                                              | 1.00                    | 5,500                   | 5506                                         | 5530                                                     | 0.022                                                                   | 0.044                                                                              |
| 22 | CCH           | Cyclohexanone                                           | 1               | 0.96           | 0.20                                  | 3.40          | 0.078                                                              | 1.00                    | 5,500                   | 5522                                         | 5603                                                     | 0.023                                                                   | 0.046                                                                              |
| 23 | CHA           | Cyclohexylamine                                         | 1               | 0.87           | 0.62                                  | 3.42          | 0.083                                                              | 1.01                    | 5,500                   | 5568                                         | 5820                                                     | 0.025                                                                   | 0.049                                                                              |
| 24 | CHX           | Cyclohexane                                             | 1               | 0.78           | 4.50                                  | 2.90          | 0.116                                                              | 1.09                    | 5,500                   | 5995                                         | 7410                                                     | 0.040                                                                   | 0.080                                                                              |
| 25 | CHN           | Cyclohexanol                                            | 1               | 0.96           | 0.15                                  | 3.45          | 0.078                                                              | 1.00                    | 5,500                   | 5517                                         | 5679                                                     | 0.023                                                                   | 0.045                                                                              |
| 26 | CPD           | 1,3-Cyclopentadiene dimer (mottlen)                     | 2               | 0.89           | 0.25                                  | 4.55          | 0.080                                                              | 1.01                    | 5,500                   | 5528                                         | 5677                                                     | 0.024                                                                   | 0.047                                                                              |
| 27 | CMP           | p-Cymene                                                | 1               | 0.86           | 0.11                                  | 4.62          | 0.078                                                              | 1.00                    | 5,500                   | 5512                                         | 5578                                                     | 0.023                                                                   | 0.045                                                                              |
| 28 | CRB           | Chlorobenzene                                           | 1               | 1.11           | 0.80                                  | 3.88          | 0.087                                                              | 1.02                    | 5,500                   | 5588                                         | 5972                                                     | 0.028                                                                   | 0.052                                                                              |
| 29 | CRS           | Cresols                                                 | 1               | 1.05           | 0.08                                  | 3.72          | 0.077                                                              | 1.00                    | 5,500                   | 5509                                         | 5646                                                     | 0.022                                                                   | 0.045                                                                              |
| 30 | CUM           | Cumene                                                  | 1               | 0.86           | 0.60                                  | 4.20          | 0.085                                                              | 1.01                    | 5,500                   | 5566                                         | 5887                                                     | 0.025                                                                   | 0.050                                                                              |
| 31 | IDA           | Decaldehyde (iso-)                                      | 1               | 0.83           | 0.01                                  | 5.00          | 0.076                                                              | 1.00                    | 5,500                   | 5501                                         | 5508                                                     | 0.022                                                                   | 0.044                                                                              |
| 32 | DAL           | Decaldehyde (n-)                                        | 1               | 0.83           | 0.00                                  | 5.01          | 0.076                                                              | 1.00                    | 5,500                   | 5500                                         | 5500                                                     | 0.022                                                                   | 0.044                                                                              |
| 33 | DCE           | Decane                                                  | 1               | 0.74           | 0.12                                  | 4.80          | 0.078                                                              | 1.00                    | 5,500                   | 5513                                         | 5590                                                     | 0.023                                                                   | 0.045                                                                              |
| 34 | DAX           | Decyl Alcohol (all isomers) (Decanol)                   | 1               | 0.83           | 0.01                                  | 5.30          | 0.076                                                              | 1.00                    | 5,500                   | 5501                                         | 5508                                                     | 0.022                                                                   | 0.044                                                                              |
| 35 | DBZ           | Decylbenzene (n-)                                       | 1               | 0.86           | 0.01                                  | 7.52          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5512                                                     | 0.022                                                                   | 0.044                                                                              |
| 36 | DAA           | Diacetone Alcohol                                       | 1               | 0.97           | 0.10                                  | 4.00          | 0.078                                                              | 1.00                    | 5,500                   | 5511                                         | 5562                                                     | 0.023                                                                   | 0.045                                                                              |
| 37 | DCH           | 1,1-Dichloroethane                                      | 1               | 1.18           | 9.90                                  | 3.41          | 0.188                                                              | 1.20                    | 5,500                   | 6589                                         | 10361                                                    | 0.079                                                                   | 0.156                                                                              |
| 38 | DPA           | Diisobutyl Phthalate (ortho-)                           | 1               | 1.05           | 0.00                                  | 9.59          | 0.076                                                              | 1.00                    | 5,500                   | 5500                                         | 5500                                                     | 0.022                                                                   | 0.044                                                                              |
| 39 | DEB           | Diethylbenzene                                          | 1               | 0.87           | 0.08                                  | 4.62          | 0.078                                                              | 1.00                    | 5,500                   | 5509                                         | 5558                                                     | 0.023                                                                   | 0.045                                                                              |
| 40 | DEG           | Diethylene Glycol                                       | 1               | 1.12           | 0.01                                  | 3.68          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5508                                                     | 0.022                                                                   | 0.044                                                                              |
| 41 | DEN           | Diethylamine                                            | 3               | 0.71           | 1.00                                  | 2.50          | 0.083                                                              | 1.02                    | 5,500                   | 5610                                         | 5884                                                     | 0.025                                                                   | 0.050                                                                              |
| 42 | DBL           | Diisobutylene                                           | 1               | 0.72           | 2.00                                  | 3.88          | 0.103                                                              | 1.04                    | 5,500                   | 5720                                         | 6654                                                     | 0.032                                                                   | 0.064                                                                              |
| 43 | DIK           | Diisobutyl Ketone                                       | 1               | 0.81           | 0.16                                  | 4.90          | 0.079                                                              | 1.00                    | 5,500                   | 5518                                         | 5623                                                     | 0.023                                                                   | 0.046                                                                              |
| 44 | DIP           | Diisopropanolamine                                      | 1               | 0.98           | 0.01                                  | 4.59          | 0.076                                                              | 1.00                    | 5,500                   | 5501                                         | 5507                                                     | 0.022                                                                   | 0.044                                                                              |
| 45 | DIX           | Diisopropylbenzene (all isomers)                        | 1               | 0.86           | 0.03                                  | 5.60          | 0.077                                                              | 1.00                    | 5,500                   | 5503                                         | 5627                                                     | 0.022                                                                   | 0.044                                                                              |
| 46 | DTL           | Dimethyl Phthalate                                      | 1               | 1.19           | 0.00                                  | 6.89          | 0.076                                                              | 1.00                    | 5,500                   | 5500                                         | 5500                                                     | 0.022                                                                   | 0.044                                                                              |
| 47 | DOP           | Dioctyl Phthalate                                       | 1               | 0.98           | 0.00                                  | 13.47         | 0.076                                                              | 1.00                    | 5,500                   | 5500                                         | 5500                                                     | 0.022                                                                   | 0.044                                                                              |
| 48 | DPN           | Dipentene                                               | 1               | 0.84           | 0.10                                  | 4.90          | 0.078                                                              | 1.00                    | 5,500                   | 5511                                         | 5577                                                     | 0.023                                                                   | 0.045                                                                              |
| 49 | DIL           | Diphenyl                                                | 1               | 0.99           | 0.01                                  | 5.31          | 0.076                                                              | 1.00                    | 5,500                   | 5501                                         | 5508                                                     | 0.022                                                                   | 0.044                                                                              |
| 50 | DDO           | Diphenyl, Diphenyl Ether Mixtures                       | 1               | 1.07           | 0.01                                  | 5.86          | 0.076                                                              | 1.00                    | 5,500                   | 5501                                         | 5509                                                     | 0.022                                                                   | 0.044                                                                              |
| 51 | DMF           | Dimethylformamide                                       | 1               | 0.95           | 0.30                                  | 2.51          | 0.078                                                              | 1.01                    | 5,500                   | 5533                                         | 5610                                                     | 0.023                                                                   | 0.046                                                                              |
| 52 | DPE           | Diphenyl Ether                                          | 1               | 1.07           | 0.01                                  | 5.87          | 0.076                                                              | 1.00                    | 5,500                   | 5501                                         | 5509                                                     | 0.022                                                                   | 0.044                                                                              |
| 53 | DPG           | Dipropylene Glycol                                      | 1               | 1.03           | 0.07                                  | 4.83          | 0.077                                                              | 1.00                    | 5,500                   | 5508                                         | 5551                                                     | 0.023                                                                   | 0.045                                                                              |
| 54 | DPX           | 1,1-, 1,2-, 1,3-Dichloropropane                         | 3               | 1.16           | 6.30                                  | 3.90          | 0.162                                                              | 1.13                    | 5,500                   | 6193                                         | 9034                                                     | 0.060                                                                   | 0.119                                                                              |
| 55 | DFF           | Distillates Flashed Feed Stocks                         | 1               | 0.75           | 2.30                                  | 3.40          | 0.102                                                              | 1.05                    | 5,500                   | 5753                                         | 6861                                                     | 0.032                                                                   | 0.064                                                                              |
| 56 | DSR           | Distillates Straight Run                                | 1               | 0.73           | 2.30                                  | 3.40          | 0.102                                                              | 1.05                    | 5,500                   | 5753                                         | 6861                                                     | 0.032                                                                   | 0.064                                                                              |
| 57 | DOZ           | Dodecene (all isomers)                                  | 1               | 0.76           | 0.02                                  | 5.81          | 0.077                                                              | 1.00                    | 5,500                   | 5502                                         | 5519                                                     | 0.022                                                                   | 0.044                                                                              |
| 58 | DDB           | Dodecylbenzene                                          | 1               | 0.86           | 4.70                                  | 8.40          | 0.240                                                              | 1.25                    | 5,500                   | 8875                                         | 12196                                                    | 0.109                                                                   | 0.218                                                                              |
| 59 | EAC           | Ethyl Acrylate                                          | 2               | 0.93           | 2.00                                  | 3.50          | 0.100                                                              | 1.04                    | 5,500                   | 5720                                         | 6543                                                     | 0.031                                                                   | 0.062                                                                              |
| 60 | EAI           | 2-Ethylhexyl acrylate                                   | 2               | 0.89           | 0.02                                  | 6.35          | 0.077                                                              | 1.00                    | 5,500                   | 5502                                         | 5520                                                     | 0.022                                                                   | 0.044                                                                              |
| 61 | EEA           | 2-Ethoxyethyl acetate                                   | 1               | 0.97           | 0.02                                  | 4.70          | 0.077                                                              | 1.00                    | 5,500                   | 5503                                         | 5517                                                     | 0.022                                                                   | 0.044                                                                              |
| 62 | ETG           | Ethoxy Triglycol (crude)                                | 1               | 1.02           | 0.00                                  | 6.14          | 0.076                                                              | 1.00                    | 5,500                   | 5500                                         | 5500                                                     | 0.022                                                                   | 0.044                                                                              |
| 63 | ETA           | Ethyl Acetate                                           | 1               | 0.90           | 4.50                                  | 3.04          | 0.119                                                              | 1.09                    | 5,500                   | 5995                                         | 7504                                                     | 0.041                                                                   | 0.082                                                                              |
| 64 | EAA           | Ethyl Acetoacetate                                      | 1               | 1.03           | 0.20                                  | 4.48          | 0.079                                                              | 1.00                    | 5,500                   | 5522                                         | 5639                                                     | 0.023                                                                   | 0.046                                                                              |
| 65 | EAL           | Ethyl Alcohol (Ethanol)                                 | 1               | 0.79           | 3.50                                  | 1.60          | 0.088                                                              | 1.07                    | 5,500                   | 5885                                         | 8255                                                     | 0.029                                                                   | 0.057                                                                              |
| 66 | ETB           | Ethyl Benzene                                           | 1               | 0.87           | 0.60                                  | 3.56          | 0.083                                                              | 1.01                    | 5,500                   | 5568                                         | 5824                                                     | 0.025                                                                   | 0.049                                                                              |
| 67 | EBT           | Ethyl Butanol                                           | 1               | 0.83           | 0.12                                  | 3.52          | 0.078                                                              | 1.00                    | 5,500                   | 5513                                         | 5564                                                     | 0.023                                                                   | 0.045                                                                              |
| 68 | EBE           | Ethyl tert-butyl ether                                  | 1               | 0.74           | 0.19                                  | 3.50          | 0.078                                                              | 1.00                    | 5,500                   | 5521                                         | 5602                                                     | 0.023                                                                   | 0.046                                                                              |

Vapor Recovery Calculations

|     | CHRIS<br>Code | Name                                 | VCS<br>Category | Liquid<br>S.G. | *Vapor<br>Press. @<br>115 F<br>(psia) | Vapor<br>S.G. | Vapor-air<br>Mixture<br>Weight<br>Density<br>(lb/ft <sup>3</sup> ) | Vapor<br>Growth<br>Rate | Max.<br>Loading<br>Rate | Vapor<br>Volumetric<br>Flow Rate<br>(bbl/hr) | Air<br>Equivalent<br>Volumetric<br>Flow Rate<br>(bbl/hr) | Pressure<br>Drop to<br>PV Valve<br>in VCS<br>(See<br>Table 3)<br>(psig) | Pressure<br>Drop to<br>Facility<br>Connection<br>in VCS (See<br>Table 5)<br>(psig) |
|-----|---------------|--------------------------------------|-----------------|----------------|---------------------------------------|---------------|--------------------------------------------------------------------|-------------------------|-------------------------|----------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| 69  | EBR           | Ethyl butyrate                       | 1               | 0.88           | 1.00                                  | 4.00          | 0.090                                                              | 1.02                    | 5,500                   | 5610                                         | 6107                                                     | 0.027                                                                   | 0.054                                                                              |
| 70  | ECY           | Ethyl Cyclohexane                    | 1               | 0.79           | 0.50                                  | 3.87          | 0.083                                                              | 1.01                    | 5,500                   | 5555                                         | 5798                                                     | 0.025                                                                   | 0.049                                                                              |
| 71  | EDC           | Ethylene dichloride                  | 1               | 1.28           | 4.00                                  | 3.42          | 0.122                                                              | 1.08                    | 5,500                   | 5940                                         | 7508                                                     | 0.041                                                                   | 0.082                                                                              |
| 72  | EGL           | Ethylene Glycol                      | 1               | 1.19           | 0.01                                  | 2.21          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5503                                                     | 0.022                                                                   | 0.044                                                                              |
| 73  | EMA           | Ethylene Glycol Butyl Ether Acetate  | 1               | 0.94           | 0.05                                  | 5.52          | 0.077                                                              | 1.00                    | 5,500                   | 5506                                         | 5644                                                     | 0.022                                                                   | 0.045                                                                              |
| 74  | EGY           | Ethylene Glycol Diacetate            | 1               | 1.10           | 0.01                                  | 5.03          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5508                                                     | 0.022                                                                   | 0.044                                                                              |
| 75  | EPE           | Ethylene Glycol Phenyl Ether         | 1               | 1.10           | 0.01                                  | 4.80          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5608                                                     | 0.022                                                                   | 0.044                                                                              |
| 76  | EHP           | Ethyl-3-ethoxypropionate             | 1               | 0.95           | 0.01                                  | 5.00          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5610                                                     | 0.022                                                                   | 0.044                                                                              |
| 77  | EHX           | 2-Ethylhexanol                       | 1               | 0.84           | 0.02                                  | 4.50          | 0.078                                                              | 1.00                    | 5,500                   | 5502                                         | 5514                                                     | 0.022                                                                   | 0.044                                                                              |
| 78  | EPR           | Ethyl Propionate                     | 1               | 0.89           | 3.50                                  | 1.60          | 0.088                                                              | 1.07                    | 5,500                   | 5885                                         | 6255                                                     | 0.029                                                                   | 0.057                                                                              |
| 79  | ETE           | Ethyl Toluene                        | 1               | 0.88           | 0.28                                  | 4.15          | 0.080                                                              | 1.01                    | 5,500                   | 5531                                         | 5679                                                     | 0.024                                                                   | 0.047                                                                              |
| 80  | FAM           | Formamide                            | 1               | 1.13           | 0.10                                  | 1.55          | 0.076                                                              | 1.00                    | 5,500                   | 5511                                         | 5520                                                     | 0.022                                                                   | 0.044                                                                              |
| 81  | FMS           | Formaldehyde Solution                | 1               | 1.13           | 0.15                                  | 1.03          | 0.078                                                              | 1.00                    | 5,500                   | 5517                                         | 5517                                                     | 0.022                                                                   | 0.044                                                                              |
| 82  | FAL           | Furfuryl Alcohol                     | 1               | 1.13           | 0.05                                  | 3.40          | 0.077                                                              | 1.00                    | 5,500                   | 5506                                         | 5526                                                     | 0.022                                                                   | 0.044                                                                              |
| 83  | FFA           | Furfural                             | 1               | 1.20           | 0.15                                  | 3.31          | 0.078                                                              | 1.00                    | 5,500                   | 5517                                         | 5575                                                     | 0.023                                                                   | 0.045                                                                              |
| 84  | GAK           | Gasoline Blending Stocks: Alkylates  | 1               | 0.75           | 12.50                                 | 3.40          | 0.217                                                              | 1.25                    | 5,500                   | 6875                                         | 11610                                                    | 0.099                                                                   | 0.196                                                                              |
| 85  | GRF           | Gasoline Blending Stocks: Reformates | 1               | 0.80           | 12.50                                 | 3.40          | 0.217                                                              | 1.25                    | 5,500                   | 6875                                         | 11610                                                    | 0.099                                                                   | 0.196                                                                              |
| 86  | GAT           | Gasolines: Automotive                | 1               | 0.74           | 12.50                                 | 3.40          | 0.217                                                              | 1.25                    | 5,500                   | 6875                                         | 11610                                                    | 0.099                                                                   | 0.196                                                                              |
| 87  | GAV           | Gasolines: Aviation                  | 1               | 0.71           | 12.50                                 | 3.40          | 0.217                                                              | 1.25                    | 5,500                   | 6875                                         | 11610                                                    | 0.099                                                                   | 0.196                                                                              |
| 88  | GCS           | Gasolines: Casinghead                | 1               | 0.87           | 12.50                                 | 3.40          | 0.217                                                              | 1.25                    | 5,500                   | 6875                                         | 11610                                                    | 0.099                                                                   | 0.196                                                                              |
| 89  | GPL           | Gasolines: Polymer                   | 1               | 0.75           | 12.50                                 | 3.40          | 0.217                                                              | 1.25                    | 5,500                   | 6875                                         | 11610                                                    | 0.099                                                                   | 0.196                                                                              |
| 90  | GSR           | Gasolines: StraightRun               | 1               | 0.75           | 12.50                                 | 3.40          | 0.217                                                              | 1.25                    | 5,500                   | 6875                                         | 11610                                                    | 0.099                                                                   | 0.196                                                                              |
| 91  | GCR           | Glycerine                            | 1               | 1.26           | 0.00                                  | 3.17          | 0.078                                                              | 1.00                    | 5,500                   | 5500                                         | 5500                                                     | 0.022                                                                   | 0.044                                                                              |
| 92  | HMX           | Heptane (all isomers)                | 1               | 0.68           | 2.50                                  | 3.45          | 0.105                                                              | 1.05                    | 5,500                   | 5775                                         | 6779                                                     | 0.034                                                                   | 0.067                                                                              |
| 93  | HEP           | Heptonic Acid                        | 1               | 0.92           | 0.01                                  | 4.49          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5507                                                     | 0.022                                                                   | 0.044                                                                              |
| 94  | HTX           | Heptanol (all isomers)               | 1               | 0.82           | 0.04                                  | 4.00          | 0.077                                                              | 1.00                    | 5,500                   | 5504                                         | 5525                                                     | 0.022                                                                   | 0.044                                                                              |
| 95  | HPX           | Heptene (all isomers)                | 2               | 0.70           | 2.90                                  | 3.40          | 0.109                                                              | 1.06                    | 5,500                   | 5819                                         | 6958                                                     | 0.036                                                                   | 0.070                                                                              |
| 96  | HXS           | Hexane (all isomers)                 | 1               | 0.68           | 7.00                                  | 3.00          | 0.142                                                              | 1.14                    | 5,500                   | 6270                                         | 8561                                                     | 0.054                                                                   | 0.106                                                                              |
| 97  | HXO           | Hexanoic Acid                        | 1               | 0.93           | 0.01                                  | 4.00          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5508                                                     | 0.022                                                                   | 0.044                                                                              |
| 98  | HXN           | Hexanol                              | 1               | 0.82           | 1.00                                  | 3.52          | 0.088                                                              | 1.02                    | 5,500                   | 5610                                         | 6031                                                     | 0.027                                                                   | 0.053                                                                              |
| 99  | HEX           | Hexene (all isomers)                 | 2               | 0.67           | 8.00                                  | 2.90          | 0.148                                                              | 1.18                    | 5,500                   | 6380                                         | 8882                                                     | 0.058                                                                   | 0.115                                                                              |
| 100 | HXG           | Hexylene Glycol                      | 1               | 0.92           | 0.01                                  | 1.10          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5501                                                     | 0.022                                                                   | 0.044                                                                              |
| 101 | IPH           | Isophorone                           | 1               | 0.93           | 0.01                                  | 4.75          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5507                                                     | 0.022                                                                   | 0.044                                                                              |
| 102 | JP4           | Jet Fuels: JP-4                      | 1               | 0.81           | 3.40                                  | 4.00          | 0.124                                                              | 1.07                    | 5,500                   | 5874                                         | 7499                                                     | 0.041                                                                   | 0.082                                                                              |
| 103 | JP5           | Jet Fuels JP-5 (Kerosene, heavy)     | 1               | 0.82           | 0.10                                  | 4.00          | 0.078                                                              | 1.00                    | 5,500                   | 5511                                         | 5582                                                     | 0.023                                                                   | 0.045                                                                              |
| 104 | KRS           | Kerosene                             | 1               | 0.81           | 0.15                                  | 4.50          | 0.079                                                              | 1.00                    | 5,500                   | 5517                                         | 5605                                                     | 0.023                                                                   | 0.046                                                                              |
| 105 | MTT           | Methyl Acetate                       | 1               | 0.92           | 6.10                                  | 2.60          | 0.122                                                              | 1.12                    | 5,500                   | 6171                                         | 7812                                                     | 0.045                                                                   | 0.089                                                                              |
| 106 | MAL           | Methyl Alcohol (Methanol)            | 1               | 0.79           | 6.63                                  | 1.10          | 0.079                                                              | 1.13                    | 5,500                   | 6229                                         | 8355                                                     | 0.030                                                                   | 0.059                                                                              |
| 107 | MAC           | Methylamyl Acetate                   | 1               | 0.86           | 0.33                                  | 4.97          | 0.082                                                              | 1.01                    | 5,500                   | 5536                                         | 5758                                                     | 0.024                                                                   | 0.048                                                                              |
| 108 | MAA           | Methylamyl Alcohol                   | 1               | 0.81           | 0.43                                  | 3.52          | 0.081                                                              | 1.01                    | 5,500                   | 5547                                         | 5730                                                     | 0.024                                                                   | 0.048                                                                              |
| 109 | MAK           | Methylamyl Keytone                   | 1               | 0.82           | 0.05                                  | 1.00          | 0.078                                                              | 1.00                    | 5,500                   | 5506                                         | 5506                                                     | 0.022                                                                   | 0.044                                                                              |
| 110 | MAM           | Methyl Acrylate                      | 2               | 0.95           | 4.10                                  | 3.00          | 0.115                                                              | 1.08                    | 5,500                   | 5951                                         | 7303                                                     | 0.039                                                                   | 0.078                                                                              |
| 111 | MBE           | Methyl Tert-Butyl Ether (MTBE)       | 1               | 0.74           | 0.04                                  | 3.10          | 0.077                                                              | 1.00                    | 5,500                   | 5504                                         | 5519                                                     | 0.022                                                                   | 0.044                                                                              |
| 112 | MBK           | Methyl Butyl Ketone                  | 1               | 0.81           | 0.97                                  | 3.50          | 0.088                                                              | 1.02                    | 5,500                   | 5607                                         | 6012                                                     | 0.028                                                                   | 0.053                                                                              |
| 113 | MBU           | Methyl Butyrate                      | 1               | 0.90           | 1.26                                  | 3.53          | 0.091                                                              | 1.03                    | 5,500                   | 5639                                         | 6168                                                     | 0.028                                                                   | 0.055                                                                              |
| 114 | MEK           | Methyl Ethyl Ketone                  | 1               | 0.80           | 4.50                                  | 2.50          | 0.108                                                              | 1.09                    | 5,500                   | 5995                                         | 7135                                                     | 0.037                                                                   | 0.074                                                                              |
| 115 | MHK           | Methyl Heptyl Ketone                 | 1               | 0.83           | 0.06                                  | 4.90          | 0.077                                                              | 1.00                    | 5,500                   | 5507                                         | 5546                                                     | 0.023                                                                   | 0.045                                                                              |
| 116 | MIK           | Methyl Isobutyl Ketone               | 1               | 0.80           | 1.15                                  | 3.45          | 0.089                                                              | 1.02                    | 5,500                   | 5627                                         | 6096                                                     | 0.027                                                                   | 0.054                                                                              |
| 117 | MMM           | Methyl methacrylate                  | 2               | 0.94           | 2.02                                  | 3.45          | 0.099                                                              | 1.04                    | 5,500                   | 5722                                         | 6538                                                     | 0.031                                                                   | 0.062                                                                              |
| 118 | MNA           | Methyl Naphthalene                   | 1               | 1.02           | 0.01                                  | 4.91          | 0.076                                                              | 1.00                    | 5,500                   | 5501                                         | 5508                                                     | 0.022                                                                   | 0.044                                                                              |
| 119 | MNS           | Mineral Spirits                      | 1               | 0.75           | 0.20                                  | 4.30          | 0.079                                                              | 1.00                    | 5,500                   | 5522                                         | 5633                                                     | 0.023                                                                   | 0.046                                                                              |
| 120 | MPL           | Morpholine                           | 1               | 1.00           | 0.80                                  | 3.00          | 0.084                                                              | 1.02                    | 5,500                   | 5588                                         | 5857                                                     | 0.025                                                                   | 0.050                                                                              |
| 121 | MRE           | Myrcene                              | 1               | 0.80           | 0.17                                  | 4.70          | 0.079                                                              | 1.00                    | 5,500                   | 5519                                         | 5625                                                     | 0.023                                                                   | 0.046                                                                              |
| 122 | PTN           | Naphtha: Petroleum                   | 1               | 0.74           | 0.19                                  | 3.50          | 0.078                                                              | 1.00                    | 5,500                   | 5521                                         | 5600                                                     | 0.023                                                                   | 0.046                                                                              |
| 123 | NSV           | Naphtha: Solvent                     | 1               | 0.87           | 0.20                                  | 3.50          | 0.078                                                              | 1.00                    | 5,500                   | 5522                                         | 5607                                                     | 0.023                                                                   | 0.046                                                                              |
| 124 | NSS           | Naphtha: Stoddard Solvent            | 1               | 0.78           | 0.20                                  | 4.30          | 0.079                                                              | 1.00                    | 5,500                   | 5522                                         | 5633                                                     | 0.023                                                                   | 0.046                                                                              |
| 125 | NVM           | Naphtha: VM&P                        | 1               | 0.77           | 0.19                                  | 4.30          | 0.079                                                              | 1.00                    | 5,500                   | 5521                                         | 5627                                                     | 0.023                                                                   | 0.046                                                                              |
| 126 | NAX           | Nonane (all isomers)                 | 1               | 0.72           | 0.27                                  | 4.40          | 0.080                                                              | 1.01                    | 5,500                   | 5530                                         | 5684                                                     | 0.024                                                                   | 0.047                                                                              |
| 127 | NON           | Nonene (all isomers)                 | 2               | 0.73           | 0.35                                  | 4.30          | 0.082                                                              | 1.01                    | 5,500                   | 5539                                         | 5733                                                     | 0.024                                                                   | 0.048                                                                              |
| 128 | NNS           | Nonyl Alcohol (all isomers)          | 1               | 0.94           | 0.10                                  | 5.00          | 0.078                                                              | 1.00                    | 5,500                   | 5511                                         | 5579                                                     | 0.023                                                                   | 0.045                                                                              |
| 129 | NNP           | Nonyl Phenol                         | 1               | 0.95           | 0.01                                  | 7.80          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5512                                                     | 0.022                                                                   | 0.044                                                                              |
| 130 | NPM           | 1-, 2-Nitropropane                   | 1               | 0.99           | 1.05                                  | 3.06          | 0.086                                                              | 1.02                    | 5,500                   | 5616                                         | 5979                                                     | 0.026                                                                   | 0.052                                                                              |
| 131 | OAX           | Octane (all isomers)                 | 1               | 0.70           | 0.79                                  | 3.90          | 0.087                                                              | 1.02                    | 5,500                   | 5587                                         | 5969                                                     | 0.026                                                                   | 0.052                                                                              |
| 132 | OCX           | Octanol (all isomers)                | 1               | 0.83           | 0.01                                  | 4.48          | 0.078                                                              | 1.00                    | 5,500                   | 5501                                         | 5507                                                     | 0.022                                                                   | 0.044                                                                              |
| 133 | OTX           | Octene (all isomers)                 | 2               | 0.72           | 0.90                                  | 3.90          | 0.088                                                              | 1.02                    | 5,500                   | 5589                                         | 6033                                                     | 0.027                                                                   | 0.053                                                                              |
| 134 | OTW           | Oil, fuel: No. 2                     | 1               | 0.88           | 0.56                                  | 8.00          | 0.095                                                              | 1.01                    | 5,500                   | 5582                                         | 6198                                                     | 0.028                                                                   | 0.056                                                                              |
| 135 | OTD           | Oil, fuel: No. 2-D                   | 1               | 0.90           | 0.69                                  | 3.40          | 0.084                                                              | 1.01                    | 5,500                   | 5578                                         | 5853                                                     | 0.025                                                                   | 0.050                                                                              |
| 136 | OFR           | Oil, fuel: No. 4                     | 1               | 0.90           | 0.15                                  | 3.40          | 0.078                                                              | 1.00                    | 5,500                   | 5517                                         | 5577                                                     | 0.023                                                                   | 0.045                                                                              |
| 137 | OFV           | Oil, fuel: No. 5                     | 1               | 0.94           | 0.15                                  | 3.40          | 0.078                                                              | 1.00                    | 5,500                   | 5517                                         | 5577                                                     | 0.023                                                                   | 0.045                                                                              |
| 138 | OSX           | Oil, fuel: No. 6                     | 1               | 0.95           | 0.15                                  | 3.40          | 0.078                                                              | 1.00                    | 5,500                   | 5517                                         | 5577                                                     | 0.023                                                                   | 0.045                                                                              |
| 139 | OIL           | Oil, misc: Crude                     | 1               | 0.95           | 0.15                                  | 3.40          | 0.078                                                              | 1.25                    | 5,500                   | 6875                                         | 8951                                                     | 0.035                                                                   | 0.070                                                                              |
| 140 | ODS           | Oil, Misc: Diesel                    | 1               | 0.90           | 0.69                                  | 3.40          | 0.084                                                              | 1.01                    | 5,500                   | 5578                                         | 5854                                                     | 0.025                                                                   | 0.050                                                                              |
| 141 | OLB           | Oil, Misc: Lubricating               | 1               | 0.90           | 0.16                                  | 1.00          | 0.076                                                              | 1.00                    | 5,500                   | 5517                                         | 5517                                                     | 0.022                                                                   | 0.044                                                                              |

Vapor Recovery Calculations

|     | CHRIS Code | Name                                        | VCS Category | Liquid S.G. | *Vapor Press. @ 115 F (psia) | Vapor S.G. | Vapor-air Mixture Weight Density (lb/ft <sup>3</sup> ) | 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) |
|-----|------------|---------------------------------------------|--------------|-------------|------------------------------|------------|--------------------------------------------------------|-------------------|-------------------|-------------------------------------|----------------------------------------------|-------------------------------------------------------|------------------------------------------------------------------|
| 142 | ORL        | Oil, Misc: Residual                         | 1            | 1.02        | 0.15                         | 1.00       | 0.076                                                  | 1.00              | 5,500             | 5517                                | 5517                                         | 0.022                                                 | 0.044                                                            |
| 143 | OTB        | Oil, Misc: Turbine                          | 1            | 0.87        | 0.30                         | 6.40       | 0.082                                                  | 1.01              | 5,500             | 5533                                | 5754                                         | 0.024                                                 | 0.048                                                            |
| 144 | PTY        | Pentane (all isomers)                       | 5            | 0.63        | 27.00                        | 2.50       | 0.350                                                  | 1.54              | 5,500             | 8470                                | 18150                                        | 0.241                                                 | 0.479                                                            |
| 145 | PTE        | Pentene (all isomers)                       | 6            | 0.64        | 24.95                        | 2.40       | 0.310                                                  | 1.50              | 5,500             | 8245                                | 16840                                        | 0.203                                                 | 0.402                                                            |
| 146 | PIN        | Pinene                                      | 1            | 0.88        | 0.38                         | 4.70       | 0.083                                                  | 1.01              | 5,500             | 5542                                | 5777                                         | 0.024                                                 | 0.048                                                            |
| 147 | PLB        | Polybutene                                  | 1            | 0.91        | 0.01                         | 1.00       | 0.076                                                  | 1.00              | 5,500             | 5501                                | 5501                                         | 0.022                                                 | 0.044                                                            |
| 148 | PGC        | Polypropylene Glycol                        | 1            | 1.01        | 0.10                         | 1.00       | 0.076                                                  | 1.00              | 5,500             | 5511                                | 5511                                         | 0.022                                                 | 0.044                                                            |
| 149 | IAC        | Propyl Acetate (iso-)                       | 1            | 0.89        | 1.80                         | 3.52       | 0.097                                                  | 1.04              | 5,500             | 5898                                | 6447                                         | 0.030                                                 | 0.060                                                            |
| 150 | PAT        | Propyl Acetate (n-)                         | 1            | 0.00        | 1.85                         | 3.52       | 0.098                                                  | 1.04              | 5,500             | 5704                                | 6472                                         | 0.031                                                 | 0.061                                                            |
| 151 | IPA        | Propyl Alcohol (iso-)                       | 1            | 0.79        | 3.00                         | 2.07       | 0.091                                                  | 1.06              | 5,500             | 5830                                | 6382                                         | 0.030                                                 | 0.059                                                            |
| 152 | PAL        | Propyl Alcohol (n-)                         | 1            | 0.80        | 1.20                         | 2.07       | 0.082                                                  | 1.02              | 5,500             | 5832                                | 5851                                         | 0.026                                                 | 0.050                                                            |
| 153 | PBY        | Propylbenzene (all isomers)                 | 1            | 0.88        | 0.20                         | 4.14       | 0.079                                                  | 1.00              | 5,500             | 5522                                | 5628                                         | 0.023                                                 | 0.046                                                            |
| 154 | IPX        | Iso-Propylcyclohexane                       | 1            | 0.80        | 0.01                         | 4.35       | 0.076                                                  | 1.00              | 5,500             | 5501                                | 5507                                         | 0.022                                                 | 0.044                                                            |
| 155 | PPG        | Propylene Glycol                            | 1            | 1.04        | 0.01                         | 2.82       | 0.076                                                  | 1.00              | 5,500             | 5501                                | 5504                                         | 0.022                                                 | 0.044                                                            |
| 156 | PGN        | Propylene Glycol Methyl Ether Acetate       | 1            | 0.92        | 0.70                         | 3.11       | 0.083                                                  | 1.01              | 5,500             | 5577                                | 5826                                         | 0.025                                                 | 0.049                                                            |
| 157 | PTT        | Propylene Tetramer                          | 1            | 0.29        | 0.02                         | 1.00       | 0.076                                                  | 1.00              | 5,500             | 5502                                | 5502                                         | 0.022                                                 | 0.044                                                            |
| 158 | SFL        | Sulfolane                                   | 1            | 1.28        | 0.01                         | 4.14       | 0.076                                                  | 1.00              | 5,500             | 5501                                | 5506                                         | 0.022                                                 | 0.044                                                            |
| 159 | STY        | Styrene                                     | 2            | 0.92        | 0.40                         | 3.60       | 0.081                                                  | 1.01              | 5,500             | 5544                                | 5719                                         | 0.024                                                 | 0.048                                                            |
| 160 | TTG        | Tetraethylene Glycol                        | 1            | 1.20        | 0.01                         | 6.70       | 0.076                                                  | 1.00              | 5,500             | 5501                                | 5511                                         | 0.022                                                 | 0.044                                                            |
| 161 | THN        | Tetrahydronaphthalene                       | 1            | 0.97        | 0.04                         | 4.56       | 0.077                                                  | 1.00              | 5,500             | 5504                                | 5529                                         | 0.022                                                 | 0.044                                                            |
| 162 | TOL        | Toluene                                     | 1            | 0.87        | 1.50                         | 3.14       | 0.091                                                  | 1.03              | 5,500             | 5665                                | 6201                                         | 0.028                                                 | 0.056                                                            |
| 163 | TCN        | 1,2,3-Trichloropropane                      | 3            | 1.39        | 0.15                         | 5.60       | 0.079                                                  | 1.00              | 5,500             | 5517                                | 5633                                         | 0.023                                                 | 0.046                                                            |
| 164 | TCP        | Tricresyl Phosphate (less than 1% of ortho) | 1            | 1.16        | 0.01                         | 12.69      | 0.077                                                  | 1.00              | 5,500             | 5501                                | 5521                                         | 0.022                                                 | 0.044                                                            |
| 165 | TEB        | Triethylbenzene                             | 1            | 0.88        | 0.02                         | 5.60       | 0.077                                                  | 1.00              | 5,500             | 5502                                | 5518                                         | 0.022                                                 | 0.044                                                            |
| 166 | TEN        | Triethylamine                               | 3            | 0.73        | 2.50                         | 3.49       | 0.105                                                  | 1.05              | 5,500             | 5775                                | 6795                                         | 0.034                                                 | 0.067                                                            |
| 167 | TEG        | Triethylene Glycol                          | 1            | 1.12        | 0.01                         | 5.17       | 0.076                                                  | 1.00              | 5,500             | 5501                                | 5508                                         | 0.022                                                 | 0.044                                                            |
| 168 | TPS        | Triethyl Phosphate                          | 1            | 1.07        | 0.03                         | 6.28       | 0.077                                                  | 1.00              | 5,500             | 5503                                | 5530                                         | 0.022                                                 | 0.044                                                            |
| 169 | TRE        | Trimethylbenzene (all isomers)              | 1            | 0.89        | 0.14                         | 4.20       | 0.078                                                  | 1.00              | 5,500             | 5515                                | 5588                                         | 0.023                                                 | 0.045                                                            |
| 170 | TRP        | Trixylenyl Phosphate                        | 1            | 1.16        | 0.00                         | 14.20      | 0.076                                                  | 1.00              | 5,500             | 5500                                | 5500                                         | 0.022                                                 | 0.044                                                            |
| 171 | THF        | Tetrahydrofuran                             | 1            | 0.89        | 8.50                         | 1.35       | 0.090                                                  | 1.17              | 5,500             | 6435                                | 7001                                         | 0.036                                                 | 0.071                                                            |
| 172 | UDC        | Undecene                                    | 1            | 0.75        | 0.05                         | 5.32       | 0.077                                                  | 1.00              | 5,500             | 5508                                | 5542                                         | 0.022                                                 | 0.045                                                            |
| 173 | UND        | Undecyl Alcohol                             | 1            | 0.84        | 0.01                         | 5.94       | 0.076                                                  | 1.00              | 5,500             | 5501                                | 5509                                         | 0.022                                                 | 0.044                                                            |
| 174 | VAM        | Vinyl Acetate                               | 2            | 0.94        | 5.80                         | 2.97       | 0.130                                                  | 1.12              | 5,500             | 6138                                | 8015                                         | 0.047                                                 | 0.093                                                            |
| 175 | XLX        | Xylenes (ortho-, meta-, para-)              | 1            | 0.89        | 0.51                         | 3.68       | 0.083                                                  | 1.01              | 5,500             | 5558                                | 5786                                         | 0.024                                                 | 0.049                                                            |

max = 0.350 1.54 max = 0.241 0.479

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

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

Table 2

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   | 54.0                        | 54.0                         |
| 3    | Tee, branch       | 8         | 2   | 39.9                        | 79.8                         |
| 4    | Tee, flow         | 8         | 1   | 13.3                        | 13.3                         |
| 5    |                   |           |     |                             |                              |
| 6    |                   |           |     |                             |                              |
|      | Sum (pipe run #1) |           |     |                             | 170.4                        |

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    | Reducer (8x6)     | 6         | 1   | 6.4                         | 6.4                          |
|      | Sum (pipe run #2) |           |     |                             | 9.4                          |

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:

| Calculate pressure drop using Darcy's equation: |                                                 |                                                                       |                               |                   |                                     |                      |                                           |                                     |                      |                                    |                              |                                          |
|-------------------------------------------------|-------------------------------------------------|-----------------------------------------------------------------------|-------------------------------|-------------------|-------------------------------------|----------------------|-------------------------------------------|-------------------------------------|----------------------|------------------------------------|------------------------------|------------------------------------------|
|                                                 |                                                 | Pipe run #1                                                           |                               |                   |                                     |                      | Pipe run #2                               |                                     |                      |                                    |                              |                                          |
|                                                 |                                                 | Description: 6" Branch (Exp tank to vapor stack)                      |                               |                   |                                     |                      | Description: 6" branch at P-V valve       |                                     |                      |                                    |                              |                                          |
|                                                 |                                                 | Pipe ID: 7.88 (in)                                                    |                               |                   |                                     |                      | Pipe ID: 6.07 (in)                        |                                     |                      |                                    |                              |                                          |
|                                                 |                                                 | Equip. Pipe Length (table 2a): 170.4 (feet)                           |                               |                   |                                     |                      | Equip. Pipe Length (table 2b): 9.4 (feet) |                                     |                      |                                    |                              |                                          |
|                                                 |                                                 | Darcy friction factor: 0.014                                          |                               |                   |                                     |                      | Darcy friction factor: 0.015              |                                     |                      |                                    |                              |                                          |
| CHRIS Code                                      | Name                                            | Vapor-air Mixture Weight Density (from Table 1) (lb/ft <sup>3</sup> ) | Liquid Transfer Rate (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) |
| 1ACN                                            | Acrylonitrile                                   | 0.095                                                                 | 5,500                         | 1,100             | 6050                                | 27.18                | 0.027                                     | 6050                                | 46.95                | 0.006                              | 0.033                        | 5758                                     |
| 2ACT                                            | Acetone                                         | 0.123                                                                 | 5,500                         | 1,200             | 6500                                | 29.53                | 0.042                                     | 6500                                | 51.22                | 0.010                              | 0.062                        | 8393                                     |
| 3ACP                                            | Acetophenone                                    | 0.085                                                                 | 5,500                         | 1,012             | 5568                                | 24.99                | 0.021                                     | 5568                                | 43.19                | 0.005                              | 0.025                        | 5681                                     |
| 4AND                                            | Adiponitrile                                    | 0.076                                                                 | 5,500                         | 1,008             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5508                                     |
| 5AEC                                            | Amyl acetate (all isomers)                      | 0.075                                                                 | 5,500                         | 1,007             | 5538                                | 24.88                | 0.018                                     | 5538                                | 42.96                | 0.004                              | 0.022                        | 5485                                     |
| 6AAI                                            | Amyl Alcohol (iso-, n-, sec-, primary)          | 0.079                                                                 | 5,500                         | 1,006             | 5533                                | 24.84                | 0.019                                     | 5533                                | 42.84                | 0.004                              | 0.023                        | 5537                                     |
| 7ATN                                            | Acetonitrile                                    | 0.076                                                                 | 5,500                         | 1,001             | 5503                                | 24.71                | 0.018                                     | 5503                                | 42.71                | 0.004                              | 0.022                        | 5505                                     |
| 8BAL                                            | Benzyl Alcohol                                  | 0.077                                                                 | 5,500                         | 1,002             | 5511                                | 24.74                | 0.018                                     | 5511                                | 42.77                | 0.004                              | 0.023                        | 5557                                     |
| 9BNZ                                            | Benzene                                         | 0.114                                                                 | 5,500                         | 1,250             | 6576                                | 30.87                | 0.042                                     | 6576                                | 53.35                | 0.010                              | 0.062                        | 8420                                     |
| 10BTX                                           | Benzene, Toluene, Xylene mixtures (10% Benzene) | 0.138                                                                 | 5,500                         | 1,250             | 6575                                | 30.87                | 0.051                                     | 6575                                | 53.35                | 0.012                              | 0.063                        | 8252                                     |
| 11BAR                                           | Butyl Acrylate (iso-, n-)                       | 0.065                                                                 | 5,500                         | 1,012             | 5568                                | 24.99                | 0.021                                     | 5568                                | 43.19                | 0.005                              | 0.025                        | 5680                                     |
| 12BAX                                           | Butyl Acetate (all isomers)                     | 0.085                                                                 | 5,500                         | 1,012             | 5568                                | 24.99                | 0.020                                     | 5568                                | 43.19                | 0.006                              | 0.025                        | 5687                                     |
| 13BAL                                           | Butyl Alcohol (iso-)                            | 0.083                                                                 | 5,500                         | 1,014             | 5569                                | 25.14                | 0.020                                     | 5569                                | 43.46                | 0.006                              | 0.025                        | 5643                                     |
| 14BAN                                           | Butyl Alcohol (n-)                              | 0.074                                                                 | 5,500                         | 1,010             | 5565                                | 24.94                | 0.018                                     | 5565                                | 43.11                | 0.004                              | 0.022                        | 5477                                     |
| 15BAS                                           | Butyl Alcohol (sec-)                            | 0.086                                                                 | 5,500                         | 1,026             | 5643                                | 25.34                | 0.021                                     | 5643                                | 43.79                | 0.005                              | 0.028                        | 5984                                     |
| 16BAT                                           | Butyl Alcohol (tert-)                           | 0.097                                                                 | 5,500                         | 1,056             | 5808                                | 26.98                | 0.028                                     | 5808                                | 45.07                | 0.006                              | 0.032                        | 6582                                     |
| 17BPH                                           | Butyl Benzyl Phthalate                          | 0.077                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5518                                     |
| 18BAD                                           | iso-Butyraldehyde                               | 0.131                                                                 | 5,500                         | 1,156             | 6358                                | 28.55                | 0.041                                     | 6358                                | 49.34                | 0.010                              | 0.061                        | 8344                                     |
| 19BTR                                           | n-Butyraldehyde                                 | 0.131                                                                 | 5,500                         | 1,156             | 6358                                | 28.55                | 0.041                                     | 6358                                | 49.34                | 0.010                              | 0.061                        | 8344                                     |
| 20BUE                                           | Butyl Toluene                                   | 0.076                                                                 | 5,500                         | 1,002             | 5511                                | 24.74                | 0.018                                     | 5511                                | 42.77                | 0.004                              | 0.023                        | 5580                                     |
| 21OLS                                           | Caprolactam Solutions                           | 0.077                                                                 | 5,500                         | 1,001             | 5506                                | 24.72                | 0.018                                     | 5506                                | 42.72                | 0.004                              | 0.022                        | 5530                                     |
| 22OCH                                           | Cyclohexanone                                   | 0.078                                                                 | 5,500                         | 1,004             | 5522                                | 24.78                | 0.019                                     | 5522                                | 42.85                | 0.004                              | 0.023                        | 5603                                     |
| 23CHA                                           | Cyclohexylamine                                 | 0.083                                                                 | 5,500                         | 1,012             | 5568                                | 25.00                | 0.020                                     | 5568                                | 43.21                | 0.005                              | 0.025                        | 5620                                     |
| 24CHX                                           | Cyclohexane                                     | 0.116                                                                 | 5,500                         | 1,090             | 5995                                | 26.92                | 0.033                                     | 5995                                | 45.82                | 0.008                              | 0.040                        | 7410                                     |
| 25CHN                                           | Cyclohexanol                                    | 0.078                                                                 | 5,500                         | 1,003             | 5517                                | 24.77                | 0.019                                     | 5517                                | 42.81                | 0.004                              | 0.023                        | 5579                                     |
| 26CPD                                           | 1,3-Cyclopentadiene dimer (molten)              | 0.080                                                                 | 5,500                         | 1,005             | 5528                                | 24.82                | 0.019                                     | 5528                                | 42.90                | 0.004                              | 0.024                        | 5677                                     |
| 27CMP                                           | p-Cymene                                        | 0.078                                                                 | 5,500                         | 1,002             | 5512                                | 24.73                | 0.018                                     | 5512                                | 42.78                | 0.004                              | 0.023                        | 5579                                     |
| 28CRB                                           | Chlorobenzene                                   | 0.087                                                                 | 5,500                         | 1,016             | 5588                                | 25.09                | 0.021                                     | 5588                                | 43.36                | 0.005                              | 0.025                        | 5692                                     |
| 29CRS                                           | Cresols                                         | 0.077                                                                 | 5,500                         | 1,002             | 5509                                | 24.73                | 0.018                                     | 5509                                | 42.75                | 0.004                              | 0.022                        | 5546                                     |
| 30CUM                                           | Cumene                                          | 0.085                                                                 | 5,500                         | 1,012             | 5568                                | 24.99                | 0.021                                     | 5568                                | 43.19                | 0.005                              | 0.025                        | 5687                                     |
| 31IDA                                           | Decaldehyde (iso-)                              | 0.076                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5508                                     |
| 32DAL                                           | Decaldehyde (n-)                                | 0.076                                                                 | 5,500                         | 1,000             | 5500                                | 24.70                | 0.018                                     | 5500                                | 42.68                | 0.004                              | 0.022                        | 5500                                     |
| 33DCE                                           | Decane                                          | 0.079                                                                 | 5,500                         | 1,002             | 5513                                | 24.75                | 0.019                                     | 5513                                | 42.78                | 0.004                              | 0.023                        | 5559                                     |
| 34DAX                                           | Decyl Alcohol (all isomers) (Decanol)           | 0.076                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5508                                     |
| 35DBZ                                           | Decylbenzene (n-)                               | 0.076                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5512                                     |
| 36DAA                                           | Dioxetane Alcohol                               | 0.079                                                                 | 5,500                         | 1,002             | 5511                                | 24.74                | 0.018                                     | 5511                                | 42.77                | 0.004                              | 0.023                        | 5582                                     |
| 37DOH                                           | 1,1-Dichloroethane                              | 0.188                                                                 | 5,500                         | 1,158             | 6589                                | 29.89                | 0.064                                     | 6589                                | 51.13                | 0.016                              | 0.079                        | 10381                                    |
| 38DPA                                           | Diethyl Phthalate (ortho-)                      | 0.076                                                                 | 5,500                         | 1,000             | 5500                                | 24.70                | 0.018                                     | 5500                                | 42.69                | 0.004                              | 0.022                        | 5506                                     |
| 39DEB                                           | Diethylbenzene                                  | 0.078                                                                 | 5,500                         | 1,002             | 5509                                | 24.73                | 0.019                                     | 5509                                | 42.75                | 0.004                              | 0.023                        | 5558                                     |
| 40DEG                                           | Diethylene Glycol                               | 0.076                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5508                                     |
| 41DEN                                           | Diethylamine                                    | 0.083                                                                 | 5,500                         | 1,020             | 5610                                | 25.19                | 0.020                                     | 5610                                | 43.64                | 0.005                              | 0.025                        | 5684                                     |
| 42DBL                                           | Diisobutylene                                   | 0.103                                                                 | 5,500                         | 1,040             | 5720                                | 25.88                | 0.026                                     | 5720                                | 44.39                | 0.006                              | 0.032                        | 6654                                     |
| 43DIK                                           | Diisobutyl Ketone                               | 0.079                                                                 | 5,500                         | 1,003             | 5518                                | 24.77                | 0.019                                     | 5518                                | 42.82                | 0.004                              | 0.023                        | 5623                                     |
| 44DIP                                           | Diisopropylamine                                | 0.076                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5507                                     |
| 45DIX                                           | Diisopropylbenzene (all isomers)                | 0.077                                                                 | 5,500                         | 1,001             | 5503                                | 24.71                | 0.018                                     | 5503                                | 42.71                | 0.004                              | 0.022                        | 5627                                     |
| 46DTL                                           | Dimethyl Phthalate                              | 0.076                                                                 | 5,500                         | 1,000             | 5500                                | 24.70                | 0.018                                     | 5500                                | 42.68                | 0.004                              | 0.022                        | 5500                                     |
| 47DOP                                           | Diethyl Phthalate                               | 0.076                                                                 | 5,500                         | 1,000             | 5500                                | 24.70                | 0.018                                     | 5500                                | 42.68                | 0.004                              | 0.022                        | 5500                                     |
| 48DPN                                           | Dipentene                                       | 0.078                                                                 | 5,500                         | 1,002             | 5511                                | 24.74                | 0.018                                     | 5511                                | 42.77                | 0.004                              | 0.023                        | 5577                                     |
| 49DOL                                           | Diphenyl                                        | 0.076                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5508                                     |
| 60DDO                                           | Diphenyl, Diphenyl Ether Mixtures               | 0.076                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5508                                     |
| 61DMF                                           | Dimethylformamide                               | 0.078                                                                 | 5,500                         | 1,006             | 5533                                | 24.84                | 0.019                                     | 5533                                | 42.94                | 0.004                              | 0.023                        | 5610                                     |
| 62DPE                                           | Diphenyl Ether                                  | 0.078                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5506                                     |
| 63DPG                                           | Dipropylene Glycol                              | 0.077                                                                 | 5,500                         | 1,001             | 5508                                | 24.73                | 0.018                                     | 5508                                | 42.74                | 0.004                              | 0.023                        | 5551                                     |
| 64DPX                                           | 1,1-, 1,2-, 1,3-Dichloropropane                 | 0.162                                                                 | 5,500                         | 1,128             | 6193                                | 27.81                | 0.048                                     | 6193                                | 48.06                | 0.011                              | 0.060                        | 9024                                     |
| 65DFF                                           | Diisobutyl Flash Feed Stocks                    | 0.102                                                                 | 5,500                         | 1,048             | 5753                                | 25.83                | 0.026                                     | 5753                                | 44.65                | 0.006                              | 0.032                        | 6681                                     |
| 66DSR                                           | Diisobutyl Straight Run                         | 0.102                                                                 | 5,500                         | 1,048             | 5753                                | 25.83                | 0.026                                     | 5753                                | 44.65                | 0.006                              | 0.032                        | 6681                                     |
| 67DOZ                                           | Dodecane (all isomers)                          | 0.077                                                                 | 5,500                         | 1,000             | 5502                                | 24.71                | 0.018                                     | 5502                                | 42.70                | 0.004                              | 0.022                        | 5519                                     |
| 68DOB                                           | Dodecylbenzene                                  | 0.240                                                                 | 5,500                         | 1,250             | 6575                                | 30.87                | 0.088                                     | 6575                                | 53.35                | 0.021                              | 0.109                        | 12196                                    |
| 69EAC                                           | Ethyl Acrylate                                  | 0.100                                                                 | 5,500                         | 1,040             | 5720                                | 25.88                | 0.025                                     | 5720                                | 44.39                | 0.006                              | 0.031                        | 6543                                     |
| 69EAI                                           | 2-Ethylhexyl acrylate                           | 0.077                                                                 | 5,500                         | 1,000             | 5502                                | 24.71                | 0.018                                     | 5502                                | 42.70                | 0.004                              | 0.022                        | 5520                                     |
| 61EBA                                           | 2-Ethoxyethyl acetate                           | 0.077                                                                 | 5,500                         | 1,000             | 5503                                | 24.71                | 0.018                                     | 5503                                | 42.70                | 0.004                              | 0.022                        | 5517                                     |
| 62ETG                                           | Ethoxy Triethyl (crude)                         | 0.078                                                                 | 5,500                         | 1,000             | 5500                                | 24.70                | 0.018                                     | 5500                                | 42.68                | 0.004                              | 0.022                        | 5500                                     |
| 63ETA                                           | Ethyl Acetate                                   | 0.119                                                                 | 5,500                         | 1,080             | 5895                                | 28.92                | 0.033                                     | 5895                                | 46.82                | 0.008                              | 0.041                        | 7504                                     |
| 64EAA                                           | Ethyl Acetoacetate                              | 0.079                                                                 | 5,500                         | 1,004             | 5522                                | 24.79                | 0.019                                     | 5522                                | 42.85                | 0.004                              | 0.023                        | 5539                                     |
| 65EAL                                           | Ethyl Alcohol (Ethanol)                         | 0.086                                                                 | 5,500                         | 1,070             | 5885                                | 26.42                | 0.023                                     | 5885                                | 45.87                | 0.005                              | 0.029                        | 6255                                     |
| 66ETB                                           | Ethyl Benzene                                   | 0.083                                                                 | 5,500                         | 1,012             | 5568                                | 24.99                | 0.020                                     | 5568                                | 43.19                | 0.005                              | 0.025                        | 5624                                     |
| 67EBT                                           | Ethyl Butanol                                   | 0.078                                                                 | 5,500                         | 1,002             | 5513                                | 24.78                | 0.019                                     | 5513                                | 42.78                | 0.004                              | 0.023                        | 5564                                     |
| 68EBE                                           | Ethyl tert-butyl ether                          | 0.078                                                                 | 5,500                         | 1,004             | 5521                                | 24.78                | 0.019                                     | 5521                                | 42.85                | 0.004                              | 0.023                        | 5602                                     |
| 69EBR                                           | Ethyl butanol                                   | 0.080                                                                 | 5,500                         | 1,020             | 5610                                | 25.19                | 0.022                                     | 5610                                | 43.54                | 0.005                              | 0.027                        | 5767                                     |
| 70ECY                                           | Ethyl Cyclohexane                               | 0.083                                                                 | 5,500                         | 1,010             | 5565                                | 24.94                | 0.020                                     | 5565                                | 43.11                | 0.005                              | 0.025                        | 5796                                     |
| 71EDC                                           | Ethylene dichloride                             | 0.122                                                                 | 5,500                         | 1,080             | 5840                                | 26.67                | 0.033                                     | 5840                                | 46.10                | 0.008                              | 0.041                        | 7508                                     |
| 72EGL                                           | Ethylene Glycol                                 | 0.078                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5503                                     |
| 73EMA                                           | Ethylene Glycol Butyl Ether Acetate             | 0.077                                                                 | 5,500                         | 1,001             | 5508                                | 24.72                | 0.018                                     | 5508                                | 42.72                | 0.004                              | 0.022                        | 5544                                     |
| 74EGY                                           | Ethylene Glycol Diacetate                       | 0.076                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.69                | 0.004                              | 0.022                        | 5508                                     |
| 75EPE                                           | Ethylene Glycol Phenyl Ether                    | 0.076                                                                 | 5,500                         | 1,000             | 5501                                | 24.70                | 0.018                                     | 5501                                | 42.6                 |                                    |                              |                                          |

Vapor Recovery Calculations

|             |                                                        | Pipe run #1                                                          |                              |                   |                                    |                      |                                    | Pipe run #2                               |                      |                                    |                              |                                         |  |
|-------------|--------------------------------------------------------|----------------------------------------------------------------------|------------------------------|-------------------|------------------------------------|----------------------|------------------------------------|-------------------------------------------|----------------------|------------------------------------|------------------------------|-----------------------------------------|--|
|             |                                                        | Description: 8" Branch (Exp trunk to vapor stack)                    |                              |                   |                                    |                      |                                    | Description: 8" branch at P-V valve       |                      |                                    |                              |                                         |  |
|             |                                                        | Pipe ID: 7.88 (in)                                                   |                              |                   |                                    |                      |                                    | Pipe ID: 6.07 (in)                        |                      |                                    |                              |                                         |  |
|             |                                                        | Equip. Pipe Length (table 2a): 170.4 (feet)                          |                              |                   |                                    |                      |                                    | Equip. Pipe Length (table 2b): 9.4 (feet) |                      |                                    |                              |                                         |  |
|             |                                                        | Darcy friction factor: 0.014                                         |                              |                   |                                    |                      |                                    | Darcy friction factor: 0.015              |                      |                                    |                              |                                         |  |
| CHRIS Code  | Name                                                   | Vapor-air Mixture Weight Density (lbm Table 1) (lb/ft <sup>3</sup> ) | Liquid Transfer Rate (ll/hr) | Vapor Growth Rate | Vapor Volumetric Flow Rate (bb/hr) | Mean Velocity (ft/s) | Pressure Drop (pipe run #1) (psig) | Vapor Volumetric Flow Rate (bb/hr)        | Mean Velocity (ft/s) | Pressure Drop (pipe run #2) (psig) | Pressure Drop (Total) (psig) | Air Equiv. Volumetric Flow Rate (bb/hr) |  |
| 100         | BKG Hexylene Glycol                                    | 0.076                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.89                | 0.004                              | 0.022                        | 5501                                    |  |
| 101         | IPH Isophorene                                         | 0.076                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.89                | 0.004                              | 0.022                        | 5501                                    |  |
| 102         | JPF Jet Fuel; JP-4                                     | 0.124                                                                | 5,600                        | 1.068             | 5874                               | 26.37                | 0.033                              | 5874                                      | 45.58                | 0.008                              | 0.041                        | 7499                                    |  |
| 103         | JFV Jet Fuel JP-5 (Kerosene, heavy)                    | 0.078                                                                | 5,600                        | 1.002             | 5511                               | 24.74                | 0.018                              | 5511                                      | 42.77                | 0.004                              | 0.023                        | 5562                                    |  |
| 104         | KRS Kerosene                                           | 0.079                                                                | 5,600                        | 1.003             | 5517                               | 24.77                | 0.019                              | 5517                                      | 42.81                | 0.004                              | 0.023                        | 5605                                    |  |
| 106         | MTT Methyl Acetate                                     | 0.122                                                                | 5,600                        | 1.122             | 6171                               | 27.71                | 0.036                              | 6171                                      | 47.89                | 0.008                              | 0.045                        | 7812                                    |  |
| 106         | MAL Methyl Alcohol (Methanol)                          | 0.079                                                                | 5,600                        | 1.133             | 6229                               | 27.97                | 0.024                              | 6229                                      | 48.34                | 0.006                              | 0.030                        | 8365                                    |  |
| 107         | MAC Methylamyl Acetate                                 | 0.082                                                                | 5,600                        | 1.007             | 5536                               | 24.86                | 0.020                              | 5536                                      | 42.86                | 0.005                              | 0.024                        | 5766                                    |  |
| 108         | MAA Methylamyl Alcohol                                 | 0.081                                                                | 5,600                        | 1.009             | 5547                               | 24.81                | 0.019                              | 5547                                      | 43.06                | 0.005                              | 0.024                        | 5730                                    |  |
| 109         | MAK Methylamyl Ketone                                  | 0.078                                                                | 5,600                        | 1.001             | 5508                               | 24.72                | 0.018                              | 5508                                      | 42.72                | 0.004                              | 0.022                        | 5505                                    |  |
| 110         | MAM Methyl Amylate                                     | 0.115                                                                | 5,600                        | 1.082             | 5961                               | 28.72                | 0.032                              | 5961                                      | 46.18                | 0.007                              | 0.039                        | 7303                                    |  |
| 111         | MBE Methyl Tert-Butyl Ether (MTBE)                     | 0.077                                                                | 5,600                        | 1.001             | 5504                               | 24.72                | 0.018                              | 5504                                      | 42.72                | 0.004                              | 0.022                        | 5519                                    |  |
| 112         | MBK Methyl Butyl Ketone                                | 0.068                                                                | 5,600                        | 1.019             | 5607                               | 25.17                | 0.021                              | 5607                                      | 43.51                | 0.005                              | 0.026                        | 6012                                    |  |
| 113         | MBU Methyl Butyrate                                    | 0.091                                                                | 5,600                        | 1.025             | 5638                               | 26.32                | 0.023                              | 5638                                      | 43.76                | 0.005                              | 0.028                        | 6168                                    |  |
| 114         | MEK Methyl Ethyl Ketone                                | 0.108                                                                | 5,600                        | 1.060             | 5995                               | 28.92                | 0.030                              | 5995                                      | 46.52                | 0.007                              | 0.037                        | 7136                                    |  |
| 116         | MRK Methyl Isobutyl Ketone                             | 0.077                                                                | 5,600                        | 1.001             | 5507                               | 24.73                | 0.018                              | 5507                                      | 42.73                | 0.004                              | 0.023                        | 5546                                    |  |
| 116         | MRK Methyl Isobutyl Ketone                             | 0.089                                                                | 5,600                        | 1.023             | 5627                               | 25.26                | 0.022                              | 5627                                      | 43.66                | 0.005                              | 0.027                        | 6086                                    |  |
| 117         | MMM Methyl methacrylate                                | 0.069                                                                | 5,600                        | 1.040             | 5722                               | 26.89                | 0.025                              | 5722                                      | 44.41                | 0.006                              | 0.031                        | 6536                                    |  |
| 118         | MMA Methyl Methacrylate                                | 0.076                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.69                | 0.004                              | 0.022                        | 5508                                    |  |
| 119         | MMS Mineral Spirits                                    | 0.079                                                                | 5,600                        | 1.004             | 5522                               | 24.79                | 0.019                              | 5522                                      | 42.86                | 0.004                              | 0.023                        | 5633                                    |  |
| 120         | MPL Morpholine                                         | 0.084                                                                | 5,600                        | 1.019             | 5588                               | 26.09                | 0.020                              | 5588                                      | 43.36                | 0.005                              | 0.026                        | 5657                                    |  |
| 121         | MRE Myrcene                                            | 0.079                                                                | 5,600                        | 1.003             | 5519                               | 24.78                | 0.019                              | 5519                                      | 42.83                | 0.004                              | 0.023                        | 5626                                    |  |
| 122         | PTN Naphtha: Petroleum                                 | 0.078                                                                | 5,600                        | 1.004             | 5521                               | 24.79                | 0.019                              | 5521                                      | 42.84                | 0.004                              | 0.023                        | 5600                                    |  |
| 123         | NBV Naphtha: Solvent                                   | 0.078                                                                | 5,600                        | 1.004             | 5522                               | 24.79                | 0.019                              | 5522                                      | 42.85                | 0.004                              | 0.023                        | 5607                                    |  |
| 124         | NBS Naphtha: Standard Solvent                          | 0.078                                                                | 5,600                        | 1.004             | 5522                               | 24.79                | 0.019                              | 5522                                      | 42.85                | 0.004                              | 0.023                        | 5633                                    |  |
| 126         | NVM Naphtha: VMAP                                      | 0.078                                                                | 5,600                        | 1.004             | 5521                               | 24.79                | 0.019                              | 5521                                      | 42.84                | 0.004                              | 0.023                        | 5627                                    |  |
| 126         | NAX Nonane (all isomers)                               | 0.080                                                                | 5,600                        | 1.006             | 5630                               | 24.83                | 0.019                              | 5530                                      | 42.91                | 0.004                              | 0.024                        | 5684                                    |  |
| 127         | NON Nonane (all isomers)                               | 0.082                                                                | 5,600                        | 1.007             | 5639                               | 24.87                | 0.020                              | 5539                                      | 42.98                | 0.005                              | 0.024                        | 5733                                    |  |
| 128         | NON Nonane (all isomers)                               | 0.078                                                                | 5,600                        | 1.002             | 5511                               | 24.74                | 0.018                              | 5511                                      | 42.77                | 0.004                              | 0.023                        | 5679                                    |  |
| 128         | NWP Nonyl Phenol                                       | 0.076                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.69                | 0.004                              | 0.023                        | 5612                                    |  |
| 130         | NPM 1, 2-Nitropropane                                  | 0.086                                                                | 5,600                        | 1.021             | 5618                               | 25.21                | 0.021                              | 5516                                      | 43.58                | 0.005                              | 0.026                        | 5979                                    |  |
| 131         | OAX Octane (all isomers)                               | 0.087                                                                | 5,600                        | 1.016             | 5687                               | 25.09                | 0.021                              | 5587                                      | 43.36                | 0.005                              | 0.026                        | 5969                                    |  |
| 132         | OCX Octanol (all isomers)                              | 0.076                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.69                | 0.004                              | 0.022                        | 5507                                    |  |
| 133         | OTX Octene (all isomers)                               | 0.088                                                                | 5,600                        | 1.018             | 5699                               | 25.14                | 0.022                              | 5699                                      | 43.45                | 0.005                              | 0.027                        | 6033                                    |  |
| 134         | OTW Oil, fuel, No. 2                                   | 0.098                                                                | 5,600                        | 1.011             | 5662                               | 24.97                | 0.023                              | 5662                                      | 43.16                | 0.005                              | 0.028                        | 6188                                    |  |
| 136         | OTD Oil, fuel, No. 2-D                                 | 0.084                                                                | 5,600                        | 1.014             | 5676                               | 25.04                | 0.020                              | 5678                                      | 43.27                | 0.005                              | 0.026                        | 5953                                    |  |
| 136         | OFR Oil, fuel, No. 4                                   | 0.078                                                                | 5,600                        | 1.003             | 5517                               | 24.77                | 0.018                              | 5517                                      | 42.81                | 0.004                              | 0.023                        | 5677                                    |  |
| 137         | ORV Oil, fuel, No. 5                                   | 0.078                                                                | 5,600                        | 1.003             | 5517                               | 24.77                | 0.018                              | 5517                                      | 42.81                | 0.004                              | 0.023                        | 5677                                    |  |
| 138         | OSX Oil, fuel, No. 6                                   | 0.078                                                                | 5,600                        | 1.003             | 5517                               | 24.77                | 0.018                              | 5517                                      | 42.81                | 0.004                              | 0.023                        | 5577                                    |  |
| 139         | OIL Oil, misc: Crude                                   | 0.078                                                                | 5,600                        | 1.250             | 6875                               | 30.87                | 0.029                              | 6875                                      | 53.35                | 0.007                              | 0.035                        | 8961                                    |  |
| 140         | ODS Oil, Misc: Diesel                                  | 0.084                                                                | 5,600                        | 1.014             | 5676                               | 25.04                | 0.020                              | 5578                                      | 43.27                | 0.005                              | 0.026                        | 5954                                    |  |
| 141         | OLB Oil, Misc: Lubricating                             | 0.076                                                                | 5,600                        | 1.003             | 5517                               | 24.77                | 0.018                              | 5517                                      | 42.81                | 0.004                              | 0.022                        | 5517                                    |  |
| 142         | ORL Oil, Misc: Residual                                | 0.078                                                                | 5,600                        | 1.003             | 5517                               | 24.77                | 0.018                              | 5517                                      | 42.81                | 0.004                              | 0.022                        | 5517                                    |  |
| 143         | OTB Oil, Misc: Turbine                                 | 0.082                                                                | 5,600                        | 1.006             | 5633                               | 24.84                | 0.020                              | 5533                                      | 42.94                | 0.005                              | 0.024                        | 5764                                    |  |
| 144         | PTY Pentane (all isomers)                              | 0.350                                                                | 5,600                        | 1.640             | 8470                               | 38.03                | 0.196                              | 8470                                      | 65.73                | 0.045                              | 0.241                        | 18160                                   |  |
| 145         | PTE Pentane (all isomers)                              | 0.310                                                                | 5,600                        | 1.489             | 8245                               | 37.02                | 0.184                              | 8245                                      | 63.98                | 0.038                              | 0.203                        | 16849                                   |  |
| 146         | PNH Phenane                                            | 0.083                                                                | 5,600                        | 1.008             | 5642                               | 24.88                | 0.020                              | 5542                                      | 43.01                | 0.005                              | 0.024                        | 5777                                    |  |
| 147         | PLB Polybutene                                         | 0.076                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.69                | 0.004                              | 0.022                        | 5501                                    |  |
| 148         | PGC Polypropylene Glycol                               | 0.076                                                                | 5,600                        | 1.002             | 5511                               | 24.74                | 0.018                              | 5511                                      | 42.77                | 0.004                              | 0.022                        | 5511                                    |  |
| 149         | IAC Propyl Acetate (iso-)                              | 0.097                                                                | 5,600                        | 1.036             | 5699                               | 25.56                | 0.025                              | 5698                                      | 44.22                | 0.006                              | 0.030                        | 5447                                    |  |
| 150         | PAT Propyl Acetate (n-)                                | 0.098                                                                | 5,600                        | 1.037             | 5704                               | 25.61                | 0.025                              | 5704                                      | 44.26                | 0.006                              | 0.031                        | 5472                                    |  |
| 151         | IPA Propyl Alcohol (iso-)                              | 0.091                                                                | 5,600                        | 1.060             | 5830                               | 26.18                | 0.024                              | 5830                                      | 45.24                | 0.006                              | 0.030                        | 5382                                    |  |
| 152         | PAL Propyl Alcohol (n-)                                | 0.082                                                                | 5,600                        | 1.024             | 5632                               | 25.29                | 0.020                              | 5632                                      | 43.71                | 0.005                              | 0.025                        | 5951                                    |  |
| 153         | PBY Propylbenzene (all isomers)                        | 0.079                                                                | 5,600                        | 1.004             | 5522                               | 24.79                | 0.019                              | 5522                                      | 42.85                | 0.004                              | 0.023                        | 5628                                    |  |
| 154         | IPX Iso-Propylcyclohexane                              | 0.076                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.69                | 0.004                              | 0.023                        | 5507                                    |  |
| 155         | PPG Propylene Glycol                                   | 0.076                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.69                | 0.004                              | 0.023                        | 5504                                    |  |
| 156         | PGN Propylene Glycol Methyl Ether Acetate              | 0.083                                                                | 5,600                        | 1.014             | 5577                               | 25.04                | 0.020                              | 5577                                      | 43.28                | 0.005                              | 0.025                        | 5826                                    |  |
| 157         | PTT Propylene Tetramer                                 | 0.076                                                                | 5,600                        | 1.000             | 5502                               | 24.71                | 0.018                              | 5502                                      | 42.70                | 0.004                              | 0.022                        | 5502                                    |  |
| 158         | SFL Sulfolane                                          | 0.076                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.69                | 0.004                              | 0.022                        | 5506                                    |  |
| 158         | STY Styrene                                            | 0.081                                                                | 5,600                        | 1.008             | 5644                               | 24.89                | 0.019                              | 5544                                      | 43.02                | 0.005                              | 0.024                        | 5719                                    |  |
| 160         | TTG Tetraethyleneglycol                                | 0.076                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.69                | 0.004                              | 0.022                        | 5511                                    |  |
| 161         | THN Tetrahydronaphthalene                              | 0.077                                                                | 5,600                        | 1.001             | 5504                               | 24.72                | 0.018                              | 5504                                      | 42.72                | 0.004                              | 0.022                        | 5529                                    |  |
| 162         | TOL Toluene                                            | 0.091                                                                | 5,600                        | 1.030             | 5686                               | 25.44                | 0.023                              | 5686                                      | 43.96                | 0.005                              | 0.028                        | 6201                                    |  |
| 163         | TGN 1,2,3-Trichloropropene                             | 0.079                                                                | 5,600                        | 1.003             | 5517                               | 24.77                | 0.019                              | 5517                                      | 42.81                | 0.004                              | 0.023                        | 5633                                    |  |
| 164         | TCP Tricresyl Phosphate (less than 1% of ortho isomer) | 0.077                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.69                | 0.004                              | 0.022                        | 5501                                    |  |
| 165         | TEB Triethylbenzene                                    | 0.077                                                                | 5,600                        | 1.000             | 5502                               | 24.71                | 0.018                              | 5502                                      | 42.70                | 0.004                              | 0.022                        | 5518                                    |  |
| 166         | TEN Triethylamine                                      | 0.106                                                                | 5,600                        | 1.050             | 5775                               | 26.93                | 0.027                              | 5775                                      | 44.82                | 0.006                              | 0.034                        | 6785                                    |  |
| 167         | TGO Triethylene Glycol                                 | 0.078                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.69                | 0.004                              | 0.022                        | 5508                                    |  |
| 168         | TPS Triethyl Phosphate                                 | 0.077                                                                | 5,600                        | 1.001             | 5503                               | 24.71                | 0.018                              | 5503                                      | 42.71                | 0.004                              | 0.022                        | 5530                                    |  |
| 169         | TRE Triethylbenzene (all isomers)                      | 0.078                                                                | 5,600                        | 1.003             | 5515                               | 24.78                | 0.019                              | 5515                                      | 42.89                | 0.004                              | 0.023                        | 5556                                    |  |
| 170         | TRP Triphenyl Phosphate                                | 0.076                                                                | 5,600                        | 1.000             | 5500                               | 24.70                | 0.018                              | 5500                                      | 42.68                | 0.004                              | 0.022                        | 5500                                    |  |
| 171         | THF Tetrahydrofuran                                    | 0.080                                                                | 5,600                        | 1.170             | 6435                               | 28.89                | 0.029                              | 6435                                      | 49.94                | 0.007                              | 0.038                        | 7001                                    |  |
| 172         | UDC Undecene                                           | 0.077                                                                | 5,600                        | 1.001             | 5506                               | 24.72                | 0.018                              | 5506                                      | 42.72                | 0.004                              | 0.022                        | 5542                                    |  |
| 173         | UND Undecyl Alcohol                                    | 0.078                                                                | 5,600                        | 1.000             | 5501                               | 24.70                | 0.018                              | 5501                                      | 42.69                | 0.004                              | 0.022                        | 5509                                    |  |
| 174         | VAM Vinyl Acetate                                      | 0.130                                                                | 5,600                        | 1.115             | 6138                               | 27.58                | 0.038                              | 6138                                      | 47.63                | 0.009                              | 0.047                        | 8015                                    |  |
| 176         | XLX Xylenes (ortho-, meta-, para-)                     | 0.083                                                                | 5,600                        | 1.010             | 5556                               | 24.85                | 0.020                              | 5556                                      | 43.12                | 0.005                              | 0.024                        | 5786                                    |  |
| max = 0.241 |                                                        |                                                                      |                              |                   |                                    |                      |                                    |                                           |                      |                                    |                              | 18160                                   |  |

Greatest pressure drop to P-V valve:

0.24 (psig)

Pentane (all isomers)

max = 0.241 18160

High velocity P-V valve pressure setting:

1.50 (psig)

Back pressure imposed by P-V valve @ highest flow rate

0.79 (psig)

Total back pressure imposed on cargo tank by venting

1.03 (psig)

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 relief valve capacity at maximum discharge rate.

Opening vacuum setting for PV Valve:

0.5 (psig)

Maximum discharge rate (total):

4300 (bb/hr)

Corresponding vacuum at max discharge rate: (see

attached PV valve flow capacity curve)

0.51 (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   | 195.0                       | 195.0                        |
| 3    | Tee, branch       | 8         | 2   | 39.9                        | 79.8                         |
| 4    | Tee, run          | 8         | 3   | 13.3                        | 39.9                         |
| 5    | Elbow, 45 deg.    | 8         | 2   | 10.2                        | 20.4                         |
| 6    | Valve, Gate       | 8         | 1   | 8.6                         | 8.6                          |
| 7    | Hose              | 8         | 1   | 50.0                        | 50.0                         |
|      |                   |           |     |                             |                              |
|      | Sum (pipe run #1) |           |     |                             | 417.0                        |

Table 6

Calculation of the Maximum Liquid Transfer Rate as Imposed by the pressure drop between the most remote tank and the facility vapor connection (Ref: 48 CFR 39.38-1(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): |                      | 417.0 (feet)                       |                              |                                              |  |  |  |  |  |  |  |  |  |
|            |                                                 |                                                                       |                               |                   | Darcy friction factor:                     |                      | 0.014                              |                              |                                              |  |  |  |  |  |  |  |  |  |
| CHRIS Code | Name                                            | Vapor-air Mixture Weight Density (from Table 1) (lb/ft <sup>3</sup> ) | Liquid Transfer Rate (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                | 0.068                              | 0.068                        | 8756                                         |  |  |  |  |  |  |  |  |  |
| 2 ACT      | Acetone                                         | 0.123                                                                 | 5,500                         | 1.200             | 6600                                       | 29.83                | 0.102                              | 0.102                        | 8363                                         |  |  |  |  |  |  |  |  |  |
| 3 ACP      | Acetophenone                                    | 0.085                                                                 | 5,500                         | 1.012             | 5586                                       | 24.99                | 0.050                              | 0.050                        | 5881                                         |  |  |  |  |  |  |  |  |  |
| 4 AND      | Adiponitrile                                    | 0.078                                                                 | 5,500                         | 1.008             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5606                                         |  |  |  |  |  |  |  |  |  |
| 5 AEG      | Amyl acetate (all isomers)                      | 0.078                                                                 | 5,500                         | 1.007             | 5536                                       | 24.88                | 0.044                              | 0.044                        | 5488                                         |  |  |  |  |  |  |  |  |  |
| 6 AAJ      | Amyl Alcohol (iso-, n-, sec-, primary)          | 0.078                                                                 | 5,500                         | 1.008             | 5533                                       | 24.84                | 0.046                              | 0.046                        | 5637                                         |  |  |  |  |  |  |  |  |  |
| 7 ATN      | Acetonitrile                                    | 0.078                                                                 | 5,500                         | 1.001             | 5503                                       | 24.71                | 0.044                              | 0.044                        | 5605                                         |  |  |  |  |  |  |  |  |  |
| 8 BAL      | Benzyl Alcohol                                  | 0.077                                                                 | 5,500                         | 1.002             | 5511                                       | 24.74                | 0.045                              | 0.046                        | 5557                                         |  |  |  |  |  |  |  |  |  |
| 9 BNZ      | Benzene                                         | 0.114                                                                 | 5,500                         | 1.250             | 6875                                       | 30.87                | 0.103                              | 0.103                        | 8420                                         |  |  |  |  |  |  |  |  |  |
| 10 BTX     | Benzene, Toluene, Xylene mixtures (10% Benzene) | 0.138                                                                 | 5,500                         | 1.250             | 6875                                       | 30.87                | 0.124                              | 0.124                        | 8252                                         |  |  |  |  |  |  |  |  |  |
| 11 BAR     | Butyl Acrylate (iso-, n-)                       | 0.086                                                                 | 5,500                         | 1.012             | 5589                                       | 24.99                | 0.051                              | 0.051                        | 6008                                         |  |  |  |  |  |  |  |  |  |
| 12 BAX     | Butyl Acetate (all isomers)                     | 0.086                                                                 | 5,500                         | 1.012             | 5586                                       | 24.99                | 0.050                              | 0.050                        | 5867                                         |  |  |  |  |  |  |  |  |  |
| 13 IAL     | Butyl Alcohol (iso-)                            | 0.083                                                                 | 5,500                         | 1.018             | 5596                                       | 25.14                | 0.050                              | 0.050                        | 6843                                         |  |  |  |  |  |  |  |  |  |
| 14 BAN     | Butyl Alcohol (n-)                              | 0.074                                                                 | 5,500                         | 1.010             | 5556                                       | 24.94                | 0.044                              | 0.044                        | 5477                                         |  |  |  |  |  |  |  |  |  |
| 15 BAS     | Butyl Alcohol (sec-)                            | 0.086                                                                 | 5,500                         | 1.026             | 5843                                       | 26.34                | 0.052                              | 0.052                        | 5994                                         |  |  |  |  |  |  |  |  |  |
| 16 BAT     | Butyl Alcohol (tert-)                           | 0.097                                                                 | 5,500                         | 1.056             | 6008                                       | 26.08                | 0.063                              | 0.063                        | 6562                                         |  |  |  |  |  |  |  |  |  |
| 17 BPH     | Butyl Benzoyl Phthalate                         | 0.077                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5518                                         |  |  |  |  |  |  |  |  |  |
| 18 BAD     | iso-Butyraldehyde                               | 0.131                                                                 | 5,500                         | 1.198             | 6358                                       | 28.55                | 0.101                              | 0.101                        | 8344                                         |  |  |  |  |  |  |  |  |  |
| 19 BTR     | n-Butyraldehyde                                 | 0.131                                                                 | 5,500                         | 1.166             | 6358                                       | 28.55                | 0.101                              | 0.101                        | 8344                                         |  |  |  |  |  |  |  |  |  |
| 20 BUE     | Butyl Toluene                                   | 0.078                                                                 | 5,500                         | 1.002             | 5511                                       | 24.74                | 0.045                              | 0.046                        | 5590                                         |  |  |  |  |  |  |  |  |  |
| 21 CLS     | Caprolactam Solutions                           | 0.077                                                                 | 5,500                         | 1.001             | 5506                                       | 24.72                | 0.044                              | 0.044                        | 5530                                         |  |  |  |  |  |  |  |  |  |
| 22 CCH     | Cyclohexanone                                   | 0.078                                                                 | 5,500                         | 1.004             | 5622                                       | 24.79                | 0.046                              | 0.046                        | 5603                                         |  |  |  |  |  |  |  |  |  |
| 23 CHA     | Cyclohexanamine                                 | 0.063                                                                 | 5,500                         | 1.012             | 5588                                       | 25.00                | 0.049                              | 0.049                        | 5820                                         |  |  |  |  |  |  |  |  |  |
| 24 CHX     | Cyclohexane                                     | 0.118                                                                 | 5,500                         | 1.080             | 5995                                       | 26.92                | 0.080                              | 0.080                        | 7410                                         |  |  |  |  |  |  |  |  |  |
| 25 CHN     | Cyclohexanone                                   | 0.078                                                                 | 5,500                         | 1.003             | 5517                                       | 24.77                | 0.045                              | 0.046                        | 5578                                         |  |  |  |  |  |  |  |  |  |
| 26 CPD     | 1,3-Cyclopentadiene dimer (molten)              | 0.080                                                                 | 5,500                         | 1.005             | 5528                                       | 24.82                | 0.047                              | 0.047                        | 5677                                         |  |  |  |  |  |  |  |  |  |
| 27 CMP     | p-Cymene                                        | 0.078                                                                 | 5,500                         | 1.002             | 5512                                       | 24.75                | 0.045                              | 0.045                        | 5579                                         |  |  |  |  |  |  |  |  |  |
| 28 CRB     | Chlorobenzene                                   | 0.087                                                                 | 5,500                         | 1.018             | 5688                                       | 25.99                | 0.052                              | 0.052                        | 5972                                         |  |  |  |  |  |  |  |  |  |
| 29 CRS     | Cresole                                         | 0.077                                                                 | 5,500                         | 1.002             | 5509                                       | 24.73                | 0.045                              | 0.046                        | 5546                                         |  |  |  |  |  |  |  |  |  |
| 48 DTL     | Dimethyl Phthalate                              | 0.079                                                                 | 5,500                         | 1.000             | 5500                                       | 24.70                | 0.044                              | 0.044                        | 5500                                         |  |  |  |  |  |  |  |  |  |
| 47 DOP     | Diethyl Phthalate                               | 0.076                                                                 | 5,500                         | 1.000             | 5500                                       | 24.70                | 0.044                              | 0.044                        | 5500                                         |  |  |  |  |  |  |  |  |  |
| 46 DPN     | Dipentene                                       | 0.078                                                                 | 5,500                         | 1.002             | 5511                                       | 24.74                | 0.046                              | 0.046                        | 5677                                         |  |  |  |  |  |  |  |  |  |
| 49 DIL     | Diphenyl                                        | 0.076                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5598                                         |  |  |  |  |  |  |  |  |  |
| 60 DDO     | Diphenyl, Diphenyl Ether Mixtures               | 0.076                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5599                                         |  |  |  |  |  |  |  |  |  |
| 51 DMF     | Dimethylformamide                               | 0.078                                                                 | 5,500                         | 1.008             | 5533                                       | 24.84                | 0.046                              | 0.046                        | 5610                                         |  |  |  |  |  |  |  |  |  |
| 62 DPE     | Diphenyl Ether                                  | 0.076                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5509                                         |  |  |  |  |  |  |  |  |  |
| 53 DPG     | Dipropylene Glycol                              | 0.077                                                                 | 5,500                         | 1.001             | 5509                                       | 24.73                | 0.045                              | 0.045                        | 5551                                         |  |  |  |  |  |  |  |  |  |
| 54 DPX     | 1,1-, 1,2-, 1,3-Dichloropropane                 | 0.162                                                                 | 5,500                         | 1.126             | 6193                                       | 27.81                | 0.119                              | 0.119                        | 9034                                         |  |  |  |  |  |  |  |  |  |
| 55 DFF     | Distillates Flashed Feed Stocks                 | 0.102                                                                 | 5,500                         | 1.046             | 5753                                       | 25.83                | 0.064                              | 0.064                        | 6661                                         |  |  |  |  |  |  |  |  |  |
| 56 DSR     | Distillates Straight Run                        | 0.102                                                                 | 5,500                         | 1.046             | 5753                                       | 25.83                | 0.064                              | 0.064                        | 6661                                         |  |  |  |  |  |  |  |  |  |
| 57 DOZ     | Dodecane (all isomers)                          | 0.077                                                                 | 5,500                         | 1.000             | 5502                                       | 24.71                | 0.044                              | 0.044                        | 5519                                         |  |  |  |  |  |  |  |  |  |
| 58 DOB     | Dodecylbenzene                                  | 0.240                                                                 | 5,500                         | 1.250             | 6875                                       | 30.87                | 0.216                              | 0.216                        | 12198                                        |  |  |  |  |  |  |  |  |  |
| 59 EAC     | Ethyl Acrylate                                  | 0.100                                                                 | 5,500                         | 1.040             | 5720                                       | 25.68                | 0.062                              | 0.062                        | 6843                                         |  |  |  |  |  |  |  |  |  |
| 60 EAJ     | 2-Ethylhexyl acrylate                           | 0.077                                                                 | 5,500                         | 1.000             | 5502                                       | 24.71                | 0.044                              | 0.044                        | 5520                                         |  |  |  |  |  |  |  |  |  |
| 61 EEA     | 2-Ethoxyethyl acetate                           | 0.077                                                                 | 5,500                         | 1.000             | 5503                                       | 24.71                | 0.044                              | 0.044                        | 5517                                         |  |  |  |  |  |  |  |  |  |
| 62 ETO     | Ethoxy Triglycol (oxide)                        | 0.078                                                                 | 5,500                         | 1.000             | 5500                                       | 24.70                | 0.044                              | 0.044                        | 5500                                         |  |  |  |  |  |  |  |  |  |
| 63 ETA     | Ethyl Acetate                                   | 0.119                                                                 | 5,500                         | 1.090             | 5985                                       | 26.92                | 0.082                              | 0.082                        | 7504                                         |  |  |  |  |  |  |  |  |  |
| 64 EAA     | Ethyl Acetoacetate                              | 0.079                                                                 | 5,500                         | 1.004             | 5522                                       | 24.79                | 0.046                              | 0.046                        | 5639                                         |  |  |  |  |  |  |  |  |  |
| 65 EAL     | Ethyl Alcohol (Ethanol)                         | 0.086                                                                 | 5,500                         | 1.070             | 5885                                       | 26.42                | 0.057                              | 0.057                        | 6256                                         |  |  |  |  |  |  |  |  |  |
| 66 ETB     | Ethyl Benzene                                   | 0.083                                                                 | 5,500                         | 1.012             | 5666                                       | 24.99                | 0.049                              | 0.049                        | 5824                                         |  |  |  |  |  |  |  |  |  |
| 67 EBT     | Ethyl Butanol                                   | 0.078                                                                 | 5,500                         | 1.002             | 5513                                       | 24.75                | 0.045                              | 0.045                        | 5684                                         |  |  |  |  |  |  |  |  |  |
| 68 EBE     | Ethyl tert-butyl ether                          | 0.078                                                                 | 5,500                         | 1.004             | 5521                                       | 24.79                | 0.048                              | 0.048                        | 5602                                         |  |  |  |  |  |  |  |  |  |
| 69 EBR     | Ethyl butyrate                                  | 0.090                                                                 | 5,500                         | 1.020             | 5610                                       | 25.19                | 0.054                              | 0.054                        | 6107                                         |  |  |  |  |  |  |  |  |  |
| 70 ECV     | Ethyl Cyclohexane                               | 0.083                                                                 | 5,500                         | 1.010             | 5555                                       | 24.94                | 0.049                              | 0.049                        | 5796                                         |  |  |  |  |  |  |  |  |  |
| 71 EDC     | Ethylene dichloride                             | 0.122                                                                 | 5,500                         | 1.080             | 5940                                       | 26.87                | 0.082                              | 0.082                        | 7508                                         |  |  |  |  |  |  |  |  |  |
| 72 EGL     | Ethylene Glycol                                 | 0.076                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5503                                         |  |  |  |  |  |  |  |  |  |
| 73 EMA     | Ethylene Glycol Butyl Ether Acetate             | 0.077                                                                 | 5,500                         | 1.001             | 5506                                       | 24.72                | 0.045                              | 0.046                        | 5544                                         |  |  |  |  |  |  |  |  |  |
| 74 EGY     | Ethylene Glycol Octoate                         | 0.076                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5508                                         |  |  |  |  |  |  |  |  |  |
| 75 EPE     | Ethylene Glycol Phenyl Ether                    | 0.076                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5508                                         |  |  |  |  |  |  |  |  |  |
| 76 EEP     | Ethyl 3-ethoxypropionate                        | 0.076                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5510                                         |  |  |  |  |  |  |  |  |  |
| 77 EHX     | 2-Ethylhexanol                                  | 0.076                                                                 | 5,500                         | 1.000             | 5502                                       | 24.71                | 0.044                              | 0.044                        | 5514                                         |  |  |  |  |  |  |  |  |  |
| 78 EPR     | Ethyl Propionate                                | 0.086                                                                 | 5,500                         | 1.070             | 5888                                       | 26.42                | 0.057                              | 0.057                        | 6255                                         |  |  |  |  |  |  |  |  |  |
| 79 ETE     | Ethyl Toluene                                   | 0.080                                                                 | 5,500                         | 1.005             | 5531                                       | 24.83                | 0.047                              | 0.047                        | 5679                                         |  |  |  |  |  |  |  |  |  |
| 80 FAM     | Formamide                                       | 0.076                                                                 | 5,500                         | 1.002             | 5511                                       | 24.74                | 0.044                              | 0.044                        | 5520                                         |  |  |  |  |  |  |  |  |  |
| 81 FMS     | Formaldehyde Solution                           | 0.076                                                                 | 5,500                         | 1.003             | 5517                                       | 24.77                | 0.044                              | 0.044                        | 5517                                         |  |  |  |  |  |  |  |  |  |
| 82 FAL     | Formyl Alcohol                                  | 0.077                                                                 | 5,500                         | 1.001             | 5506                                       | 24.72                | 0.044                              | 0.044                        | 5528                                         |  |  |  |  |  |  |  |  |  |
| 83 FFA     | Formic Acid                                     | 0.079                                                                 | 5,500                         | 1.003             | 5517                                       | 24.77                | 0.045                              | 0.045                        | 5675                                         |  |  |  |  |  |  |  |  |  |
| 84 GAK     | Gasoline Blending Stocks: Alkylates             | 0.217                                                                 | 5,500                         | 1.250             | 6875                                       | 30.87                | 0.196                              | 0.196                        | 11610                                        |  |  |  |  |  |  |  |  |  |
| 85 GRF     | Gasoline Blending Stocks: Reformates            | 0.217                                                                 | 5,500                         | 1.250             | 6875                                       | 30.87                | 0.196                              | 0.196                        | 11610                                        |  |  |  |  |  |  |  |  |  |
| 86 GAT     | Gasolines: Automotive                           | 0.217                                                                 | 5,500                         | 1.250             | 6875                                       | 30.87                | 0.196                              | 0.196                        | 11610                                        |  |  |  |  |  |  |  |  |  |
| 87 GAV     | Gasolines: Aviation                             | 0.217                                                                 | 5,500                         | 1.250             | 6875                                       | 30.87                | 0.196                              | 0.196                        | 11610                                        |  |  |  |  |  |  |  |  |  |
| 88 GCS     | Gasolines: Casinghead                           | 0.217                                                                 | 5,500                         | 1.250             | 6875                                       | 30.87                | 0.196                              | 0.196                        | 11610                                        |  |  |  |  |  |  |  |  |  |
| 89 GPL     | Gasolines: Polymer                              | 0.217                                                                 | 5,500                         | 1.250             | 6875                                       | 30.87                | 0.196                              | 0.196                        | 11610                                        |  |  |  |  |  |  |  |  |  |
| 90 GSR     | Gasolines: Straight Run                         | 0.217                                                                 | 5,500                         | 1.250             | 6875                                       | 30.87                | 0.196                              | 0.196                        | 11610                                        |  |  |  |  |  |  |  |  |  |
| 91 GCR     | Glycoline                                       | 0.076                                                                 | 5,500                         | 1.000             | 5500                                       | 24.70                | 0.044                              | 0.044                        | 5500                                         |  |  |  |  |  |  |  |  |  |
| 92 HMX     | Heptane (all isomers)                           | 0.105                                                                 | 5,500                         | 1.050             | 5775                                       | 25.93                | 0.067                              | 0.067                        | 6779                                         |  |  |  |  |  |  |  |  |  |
| 93 HEP     | Heptanoic Acid                                  | 0.076                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5507                                         |  |  |  |  |  |  |  |  |  |
| 94 HTX     | Heptanol (all isomers)                          | 0.077                                                                 | 5,500                         | 1.001             | 5504                                       | 24.72                | 0.044                              | 0.044                        | 5525                                         |  |  |  |  |  |  |  |  |  |
| 96 HPT     | Heptane (all isomers)                           | 0.109                                                                 | 5,500                         | 1.058             | 5819                                       | 25.13                | 0.070                              | 0.070                        | 6968                                         |  |  |  |  |  |  |  |  |  |
| 96 HXS     | Hexane (all isomers)                            | 0.142                                                                 | 5,500                         | 1.140             | 6270                                       | 25.15                | 0.106                              | 0.106                        | 8661                                         |  |  |  |  |  |  |  |  |  |
| 97 HXO     | Hexanoic Acid                                   | 0.076                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5506                                         |  |  |  |  |  |  |  |  |  |
| 98 HXN     | Hexanol                                         | 0.083                                                                 | 5,500                         | 1.020             | 5610                                       | 25.19                | 0.053                              | 0.053                        | 6063                                         |  |  |  |  |  |  |  |  |  |
| 99 HEX     | Hexane (all isomers)                            | 0.148                                                                 | 5,500                         | 1.160             | 6380                                       | 28.65                | 0.115                              | 0.115                        | 8631                                         |  |  |  |  |  |  |  |  |  |
| 100 HXG    | Hexylene Glycol                                 | 0.076                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5507                                         |  |  |  |  |  |  |  |  |  |
| 101 JPH    | Isophorene                                      | 0.076                                                                 | 5,500                         | 1.000             | 5501                                       | 24.70                | 0.044                              | 0.044                        | 5507                                         |  |  |  |  |  |  |  |  |  |
| 102 JPF    | Jet Fuels: JP-4                                 | 0.124                                                                 | 5,500                         | 1.068             | 5874                                       | 26.37                | 0.082                              | 0.082                        | 7498                                         |  |  |  |  |  |  |  |  |  |
| 103 JPV    | Jet Fuels: JP-5 (Kerosene, heavy)               | 0.078                                                                 | 5,500                         | 1.002             | 5511                                       | 24.74                | 0.045                              | 0.045                        | 5562                                         |  |  |  |  |  |  |  |  |  |
| 104 KRS    | Kerosene                                        | 0.079                                                                 | 5,500                         | 1.003             | 5517                                       | 24.77                | 0.048                              | 0.048                        | 5605                                         |  |  |  |  |  |  |  |  |  |
| 105 MIT    | Methyl Acetate                                  | 0.122                                                                 | 5,500                         | 1.122             | 6171                                       | 27.71                | 0.089                              | 0.089                        | 7812                                         |  |  |  |  |  |  |  |  |  |
| 106 MAL    | Methyl Alcohol (Methanol)                       | 0.079                                                                 | 5,500                         | 1.133             | 6229                                       | 27.97                | 0.059                              | 0.059                        | 6355                                         |  |  |  |  |  |  |  |  |  |
| 107 MAC    | Methylamyl Acetate                              | 0.082                                                                 | 5,500                         | 1.007             | 5536                                       | 24.88                | 0.048                              | 0.048                        | 5756                                         |  |  |  |  |  |  |  |  |  |
| 108 MAA    | Methylamyl Alcohol                              | 0.081                                                                 | 5,500                         | 1.009             | 5547                                       | 24.91                | 0.048                              | 0.048                        | 5730                                         |  |  |  |  |  |  |  |  |  |
| 109 MAK    | Methylamyl Ketone                               | 0.076                                                                 | 5,500                         | 1.001             | 5506                                       | 24.72                | 0.044                              | 0.044                        | 5506                                         |  |  |  |  |  |  |  |  |  |
| 110 MAM    | Methyl Acrylate                                 | 0.115                                                                 | 5,500                         | 1.082             | 5951                                       | 28.72                | 0.078                              | 0.078                        | 7303                                         |  |  |  |  |  |  |  |  |  |

|                                            |              |  |  |
|--------------------------------------------|--------------|--|--|
| Pipe run #1                                |              |  |  |
| Description:                               | 8" Piping    |  |  |
| Pipe ID:                                   | 7.98 (in)    |  |  |
| Equivalent Length of Pipe (from Table 4a): | 417.0 (feet) |  |  |
| Darcy friction factor:                     | 0.014        |  |  |

|     |     |                                                    |        |       |       |      |       |       |       |       |
|-----|-----|----------------------------------------------------|--------|-------|-------|------|-------|-------|-------|-------|
| 111 | MBE | Methyl Tert-Butyl Ether (MTBE)                     | 0.0771 | 5,500 | 1.001 | 5504 | 24.72 | 0.044 | 0.044 | 5519  |
| 112 | MBK | Methyl Butyl Ketone                                | 0.088  | 5,500 | 1.019 | 5607 | 25.17 | 0.053 | 0.053 | 5612  |
| 113 | MBU | Methyl Butyrate                                    | 0.091  | 5,500 | 1.025 | 5639 | 25.32 | 0.055 | 0.055 | 5668  |
| 114 | MEK | Methyl Ethyl Ketone                                | 0.108  | 5,500 | 1.090 | 5695 | 26.52 | 0.074 | 0.074 | 5735  |
| 115 | MEK | Methyl Propyl Ketone                               | 0.077  | 5,500 | 1.001 | 5507 | 24.73 | 0.045 | 0.045 | 5548  |
| 116 | MEK | Methyl Isobutyl Ketone                             | 0.069  | 5,500 | 1.023 | 5627 | 25.26 | 0.054 | 0.054 | 5696  |
| 117 | MMM | Methyl methacrylate                                | 0.099  | 5,500 | 1.040 | 5722 | 26.69 | 0.062 | 0.062 | 5838  |
| 118 | MNA | Methyl Naphthalene                                 | 0.076  | 5,500 | 1.000 | 5501 | 24.70 | 0.044 | 0.044 | 5508  |
| 119 | MNS | Mineral Spirits                                    | 0.079  | 5,500 | 1.004 | 5522 | 24.79 | 0.046 | 0.046 | 5533  |
| 120 | MPL | Morpholine                                         | 0.064  | 5,500 | 1.018 | 5588 | 25.09 | 0.050 | 0.050 | 5667  |
| 121 | MRE | Myrcene                                            | 0.079  | 5,500 | 1.003 | 5519 | 24.78 | 0.046 | 0.046 | 5526  |
| 122 | PTN | Naphtha: Petroleum                                 | 0.078  | 5,500 | 1.004 | 5521 | 24.79 | 0.046 | 0.046 | 5500  |
| 123 | NSV | Naphtha: Solvent                                   | 0.078  | 5,500 | 1.004 | 5522 | 24.79 | 0.046 | 0.046 | 5507  |
| 124 | NBS | Naphtha: Standard Solvent                          | 0.079  | 5,500 | 1.004 | 5522 | 24.79 | 0.046 | 0.046 | 5533  |
| 125 | NVM | Naphtha: VM&P                                      | 0.079  | 5,500 | 1.004 | 5521 | 24.78 | 0.046 | 0.046 | 5527  |
| 126 | NAX | Nonane (all isomers)                               | 0.060  | 5,500 | 1.005 | 5530 | 24.83 | 0.047 | 0.047 | 5584  |
| 127 | NON | Nonane (all isomers)                               | 0.062  | 5,500 | 1.007 | 5539 | 24.87 | 0.048 | 0.048 | 5733  |
| 128 | NNS | Nonyl Alcohol (all isomers)                        | 0.078  | 5,500 | 1.002 | 5511 | 24.74 | 0.045 | 0.045 | 5579  |
| 129 | NBP | Nonyl Phenol                                       | 0.078  | 5,500 | 1.000 | 5501 | 24.70 | 0.044 | 0.044 | 5512  |
| 130 | NPM | n-Propylamine                                      | 0.086  | 5,500 | 1.021 | 5616 | 25.21 | 0.052 | 0.052 | 5979  |
| 131 | OAX | Octane (all isomers)                               | 0.067  | 5,500 | 1.016 | 5587 | 25.09 | 0.052 | 0.052 | 5969  |
| 132 | OCX | Octanol (all isomers)                              | 0.078  | 5,500 | 1.000 | 5501 | 24.70 | 0.044 | 0.044 | 5507  |
| 133 | OTX | Octene (all isomers)                               | 0.088  | 5,500 | 1.018 | 5599 | 25.14 | 0.053 | 0.053 | 6003  |
| 134 | OTW | Oil, Fuel No. 2                                    | 0.095  | 5,500 | 1.011 | 5582 | 24.97 | 0.056 | 0.056 | 6198  |
| 135 | OTD | Oil, Fuel No. 2-D                                  | 0.084  | 5,500 | 1.014 | 5576 | 25.04 | 0.050 | 0.050 | 5853  |
| 136 | OFR | Oil, Fuel No. 4                                    | 0.078  | 5,500 | 1.003 | 5517 | 24.77 | 0.045 | 0.045 | 5577  |
| 137 | OFV | Oil, Fuel No. 5                                    | 0.078  | 5,500 | 1.003 | 5517 | 24.77 | 0.045 | 0.045 | 5577  |
| 138 | OSX | Oil, Fuel No. 6                                    | 0.078  | 5,500 | 1.003 | 5517 | 24.77 | 0.045 | 0.045 | 5577  |
| 139 | OIL | Oil, Misc: Crude                                   | 0.078  | 5,500 | 1.250 | 5875 | 30.87 | 0.070 | 0.070 | 6861  |
| 140 | ODB | Oil, Misc: Diesel                                  | 0.084  | 5,500 | 1.014 | 5578 | 25.04 | 0.050 | 0.050 | 6864  |
| 141 | OLB | Oil, Misc: Lubricating                             | 0.078  | 5,500 | 1.003 | 5517 | 24.77 | 0.044 | 0.044 | 5517  |
| 142 | ORL | Oil, Misc: Residual                                | 0.078  | 5,500 | 1.003 | 5517 | 24.77 | 0.044 | 0.044 | 5517  |
| 143 | OTB | Oil, Misc: Turbine                                 | 0.062  | 5,500 | 1.008 | 5533 | 24.84 | 0.048 | 0.048 | 6764  |
| 144 | PTY | Pentane (all isomers)                              | 0.350  | 5,500 | 1.540 | 6470 | 38.03 | 0.479 | 0.479 | 18150 |
| 145 | PTE | Pentene (all isomers)                              | 0.310  | 5,500 | 1.499 | 6245 | 37.02 | 0.462 | 0.462 | 16640 |
| 146 | PN  | Pinene                                             | 0.093  | 5,500 | 1.008 | 5542 | 24.86 | 0.048 | 0.048 | 6777  |
| 147 | PAB | Polylutene                                         | 0.076  | 5,500 | 1.000 | 5501 | 24.70 | 0.044 | 0.044 | 5501  |
| 148 | PBG | Propylene Glycol                                   | 0.076  | 5,500 | 1.002 | 5511 | 24.74 | 0.044 | 0.044 | 5511  |
| 149 | IAG | Propyl Acetate (iso-)                              | 0.087  | 5,500 | 1.038 | 5688 | 25.58 | 0.060 | 0.060 | 6447  |
| 150 | PAT | Propyl Acetate (n-)                                | 0.098  | 5,500 | 1.037 | 5704 | 25.61 | 0.061 | 0.061 | 6473  |
| 151 | IPA | Propyl Alcohol (iso-)                              | 0.091  | 5,500 | 1.060 | 5630 | 26.18 | 0.059 | 0.059 | 6382  |
| 152 | PAL | Propyl Alcohol (n-)                                | 0.082  | 5,500 | 1.024 | 5632 | 25.29 | 0.050 | 0.050 | 6351  |
| 153 | PEY | Propylbenzene (all isomers)                        | 0.076  | 5,500 | 1.004 | 5522 | 24.79 | 0.046 | 0.046 | 5528  |
| 154 | PX  | iso-Propylcyclohexane                              | 0.076  | 5,500 | 1.000 | 5501 | 24.70 | 0.044 | 0.044 | 5507  |
| 155 | PPG | Propylene Glycol                                   | 0.076  | 5,500 | 1.000 | 5501 | 24.70 | 0.044 | 0.044 | 5504  |
| 156 | PGN | Propylene Glycol Methyl Ether Acetate              | 0.063  | 5,500 | 1.014 | 5577 | 25.04 | 0.049 | 0.049 | 5628  |
| 157 | PTT | Propylene Tetramer                                 | 0.076  | 5,500 | 1.000 | 5502 | 24.71 | 0.044 | 0.044 | 5502  |
| 158 | SFL | Sulfolane                                          | 0.076  | 5,500 | 1.000 | 5501 | 24.70 | 0.044 | 0.044 | 5506  |
| 159 | STY | Styrene                                            | 0.061  | 5,500 | 1.006 | 5544 | 24.86 | 0.045 | 0.045 | 5719  |
| 160 | TTG | Tetramethylene Glycol                              | 0.078  | 5,500 | 1.000 | 5501 | 24.70 | 0.044 | 0.044 | 5511  |
| 161 | THN | Tetrahydronaphthalene                              | 0.077  | 5,500 | 1.001 | 5504 | 24.72 | 0.044 | 0.044 | 5528  |
| 162 | TOL | Toluene                                            | 0.091  | 5,500 | 1.030 | 5685 | 25.44 | 0.056 | 0.056 | 6201  |
| 163 | TON | 1,2,3-Trichloropropane                             | 0.079  | 5,500 | 1.003 | 5517 | 24.77 | 0.046 | 0.046 | 5633  |
| 164 | TOP | Tricresyl Phosphate (less than 1% of ortho isomer) | 0.077  | 5,500 | 1.000 | 5501 | 24.70 | 0.044 | 0.044 | 5521  |
| 165 | TEB | Triethylbenzene                                    | 0.077  | 5,500 | 1.000 | 5502 | 24.71 | 0.044 | 0.044 | 5518  |
| 166 | TEN | Triethylamine                                      | 0.106  | 5,500 | 1.066 | 5775 | 25.93 | 0.067 | 0.067 | 6795  |
| 167 | TEG | Triethylene Glycol                                 | 0.076  | 5,500 | 1.000 | 5501 | 24.70 | 0.044 | 0.044 | 5508  |
| 168 | TPS | Triethyl Phosphate                                 | 0.077  | 5,500 | 1.001 | 5503 | 24.71 | 0.044 | 0.044 | 5535  |
| 169 | TRE | Trimethylbenzene (all isomers)                     | 0.076  | 5,500 | 1.003 | 5515 | 24.76 | 0.045 | 0.045 | 5568  |
| 170 | TRP | Triethyl Phosphate                                 | 0.078  | 5,500 | 1.000 | 5500 | 24.70 | 0.044 | 0.044 | 5500  |
| 171 | THF | Tetrahydrofuran                                    | 0.090  | 5,500 | 1.170 | 5435 | 28.89 | 0.071 | 0.071 | 7001  |
| 172 | UDC | Undecane                                           | 0.077  | 5,500 | 1.001 | 5506 | 24.72 | 0.045 | 0.045 | 5542  |
| 173 | UND | Undecyl Alcohol                                    | 0.078  | 5,500 | 1.000 | 5501 | 24.70 | 0.044 | 0.044 | 5509  |
| 174 | VAM | Vinyl Acetate                                      | 0.130  | 5,500 | 1.116 | 6136 | 27.56 | 0.093 | 0.093 | 8015  |
| 175 | XLX | Xylenes (ortho-, meta-, para-)                     | 0.083  | 5,500 | 1.010 | 5556 | 24.95 | 0.049 | 0.049 | 5786  |

## 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:

0.48 (psig)

e. Max Allowable Back Pressure at Facility Connection:

0.72 (psig)

for

Pentane (all isomers)

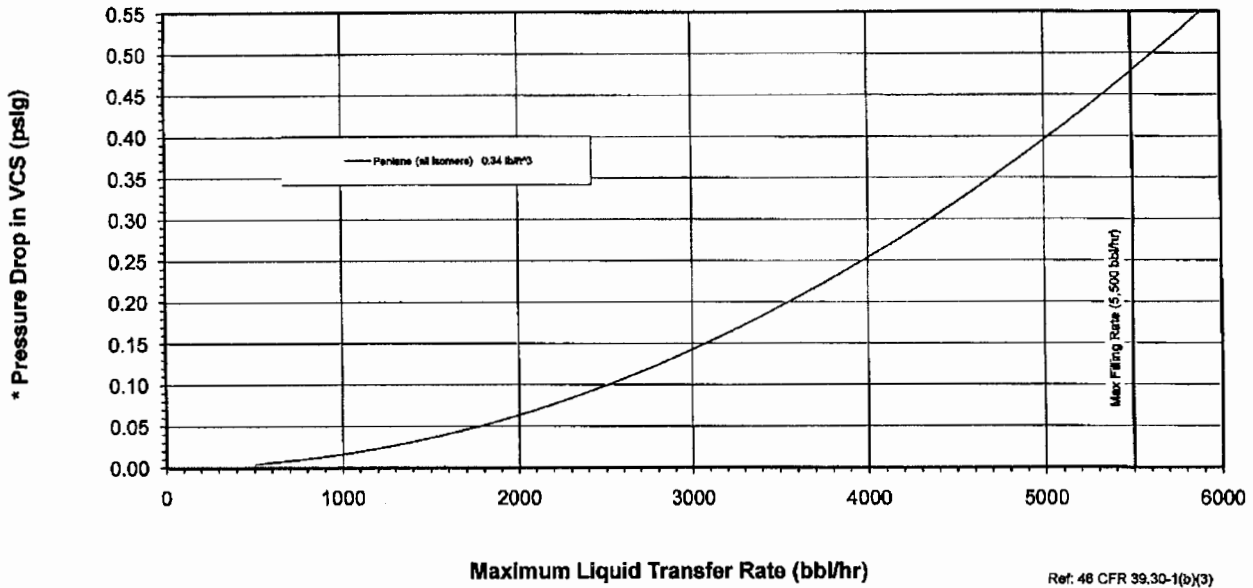
Conclusion:

For the cargo with the highest pressure drop (Pentane), the pressure drop is 0.48 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 0.72 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)

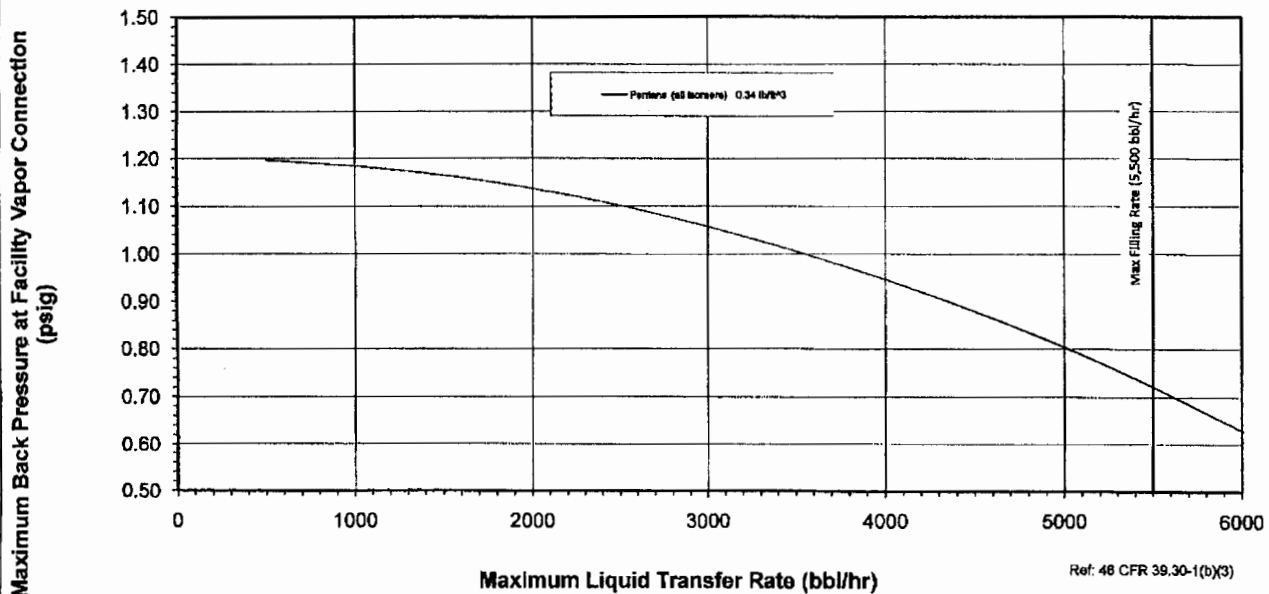
Curve of Loading Rate vs. Pressure Drop

Conrad Hull C-994 THRU C-997

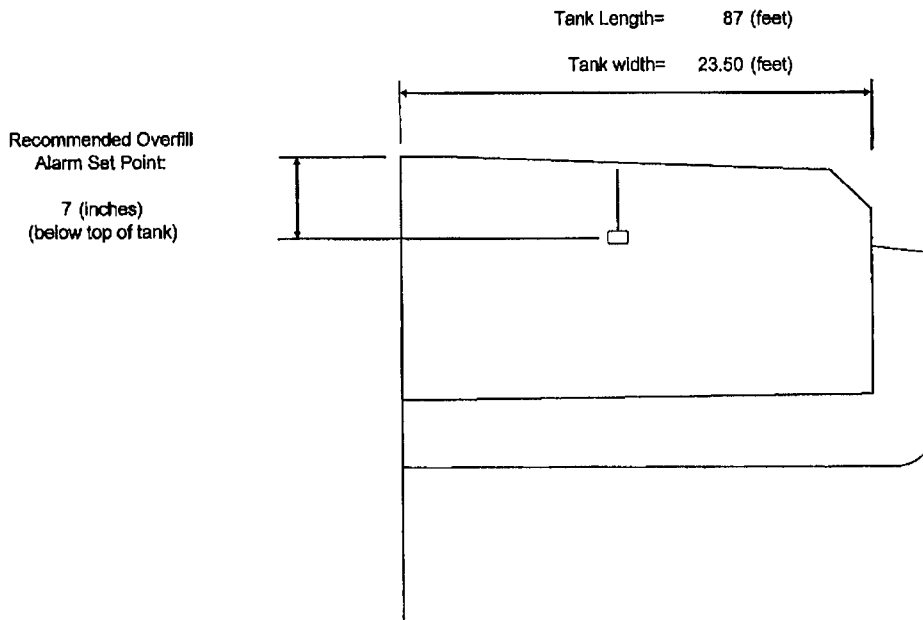


Curve of Allowable Back Pressure at Facility Connection

Conrad Hull C-994 THRU C-997



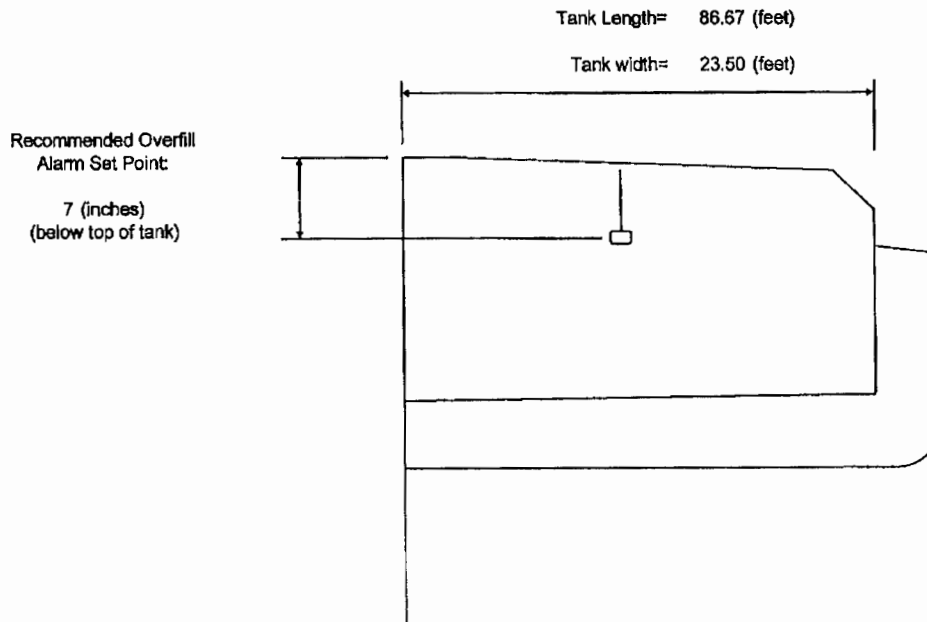
**Conrad C-994 THRU C-997**  
**Calculation of Overfill Alarm Set Point**  
**(Cargo Tank No. 1 P/S)**



|                                                |   |                 |                          |
|------------------------------------------------|---|-----------------|--------------------------|
| Maximum (per tank) Cargo Loading Rate          | = | 5,500 (bbl/hr)  |                          |
|                                                | = | 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) =          |   | 5278 BBL        |                          |
| Capacity to 7" below dk at CL (17'-1" ABL) =   |   | 5168 BBL        |                          |
| Volume above alarm =                           |   | 110.1 BBL       | RESULT OK                |
| **Recommended set point of                     | = | 7 (inches)      | [Based on 98% full tank] |

|                                                                    |          |
|--------------------------------------------------------------------|----------|
| **Note: Or 98.5%, whichever is lower (to comply with 33CFR155.775) |          |
| Capacity at 98.5% =                                                | 5199 BBL |
| Dist from TT at CL =                                               | 0.49 ft  |

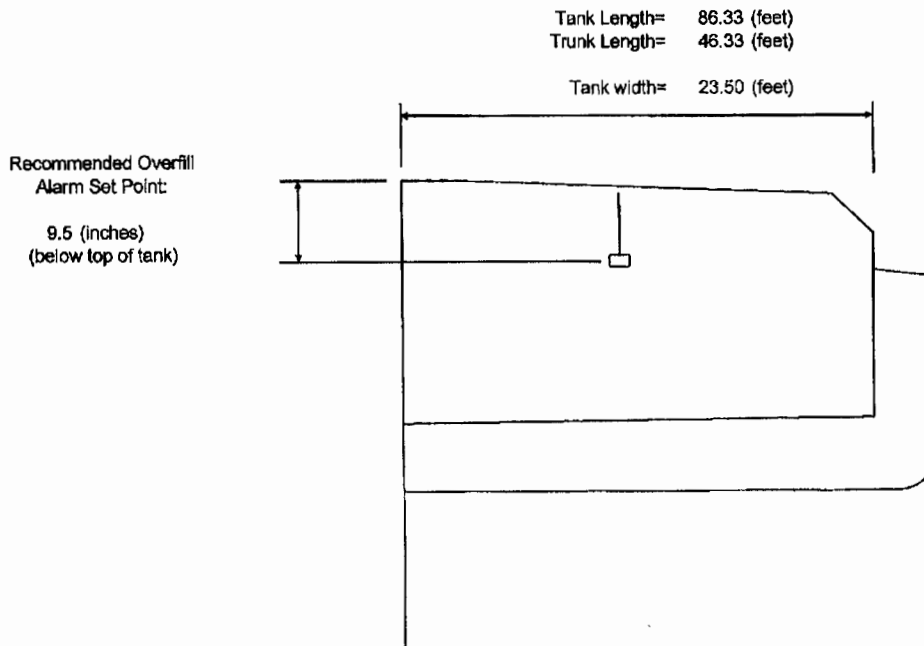
**Conrad C-994 THRU C-997**  
**Calculation of Overfill Alarm Set Point**  
**(Cargo Tank No. 2 P/S)**



|                                                |   |                 |                          |
|------------------------------------------------|---|-----------------|--------------------------|
| Maximum (per tank) Cargo Loading Rate          | = | 5,500 (bbl/hr)  |                          |
|                                                | = | 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) =          |   | 5258 BBL        |                          |
| Capacity to 7" below dk at CL (17'-1" ABL) =   |   | 5149 BBL        |                          |
| Volume above alarm =                           |   | 109.6 BBL       | RESULT OK                |
| **Recommended set point of                     | = | 7 (inches)      | [Based on 98% full tank] |

|                                                                    |          |
|--------------------------------------------------------------------|----------|
| **Note: Or 98.5%, whichever is lower (to comply with 33CFR155.775) |          |
| Capacity at 98.5% =                                                | 5179 BBL |
| Dist from TT at CL =                                               | 0.49 ft. |

**Conrad C-994 THRU C-997**  
**Calculation of Overfill Alarm Set Point**  
**(Cargo Tank No. 3 P/S)**



|                                                   |   |                 |           |
|---------------------------------------------------|---|-----------------|-----------|
| Maximum (per tank) Cargo Loading Rate             | = | 5,500 (bbl/hr)  |           |
|                                                   | = | 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) =             |   | 4409 BBL        |           |
| Capacity to 9.5" below dk at CL (16'-10.5" ABL) = |   | 4314 BBL        |           |
| Volume above alarm =                              |   | 95.1 BBL        | RESULT OK |
| **Recommended set point of                        | = | 9.5 (inches)    |           |

**\*\*Note: Or 98.5%, whichever is lower (to comply with 33CFR155.775)**  
 Capacity at 98.5% = 4343 BBL  
 Dist from TT at CL = 0.63 ft.

## Vapor Recovery Calculations

### 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. ~~994~~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

## Vapor Recovery Calculations

### **LIST OF ATTACHMENTS**

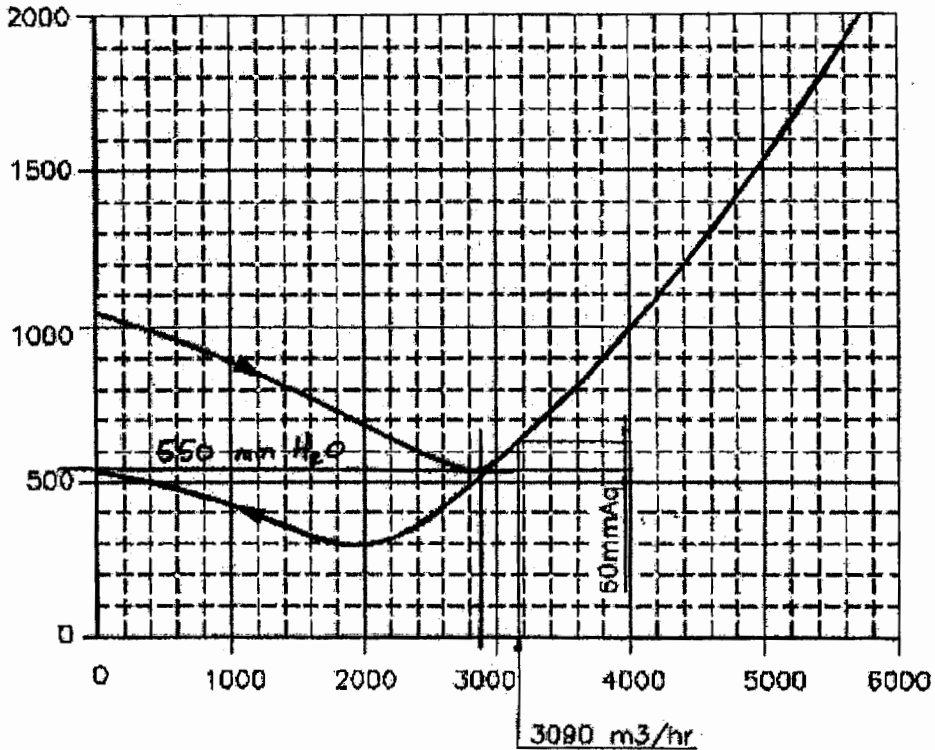
1. Flow Capacity Curves for High-Velocity P-V Valve
2. Vacuum flow diagram for High-Velocity P-V Valve
3. USCG Approval Certificate for High-Velocity P-V Valve

CONRAD C-994 THRU C-997

# HIGH VELOCITY VENT VALVE FLOW CAPACITY CURVE

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

VALVE INLET PRESSURE, mmAq  
 (1mmAq = 0.0014289PSI)



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

$$18,150 \text{ bbl/hr} \times \frac{1 \text{ m}^3/\text{hr}}{6.289 \text{ bbl/hr}} = 2,886 \text{ m}^3/\text{hr}$$

$$550 \text{ mm H}_2\text{O} \times \frac{0.00143 \text{ PSI}}{\text{mm H}_2\text{O}} = 0.79 \text{ PSI}$$

| 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=1.0332Kg/cm <sup>2</sup> |               |

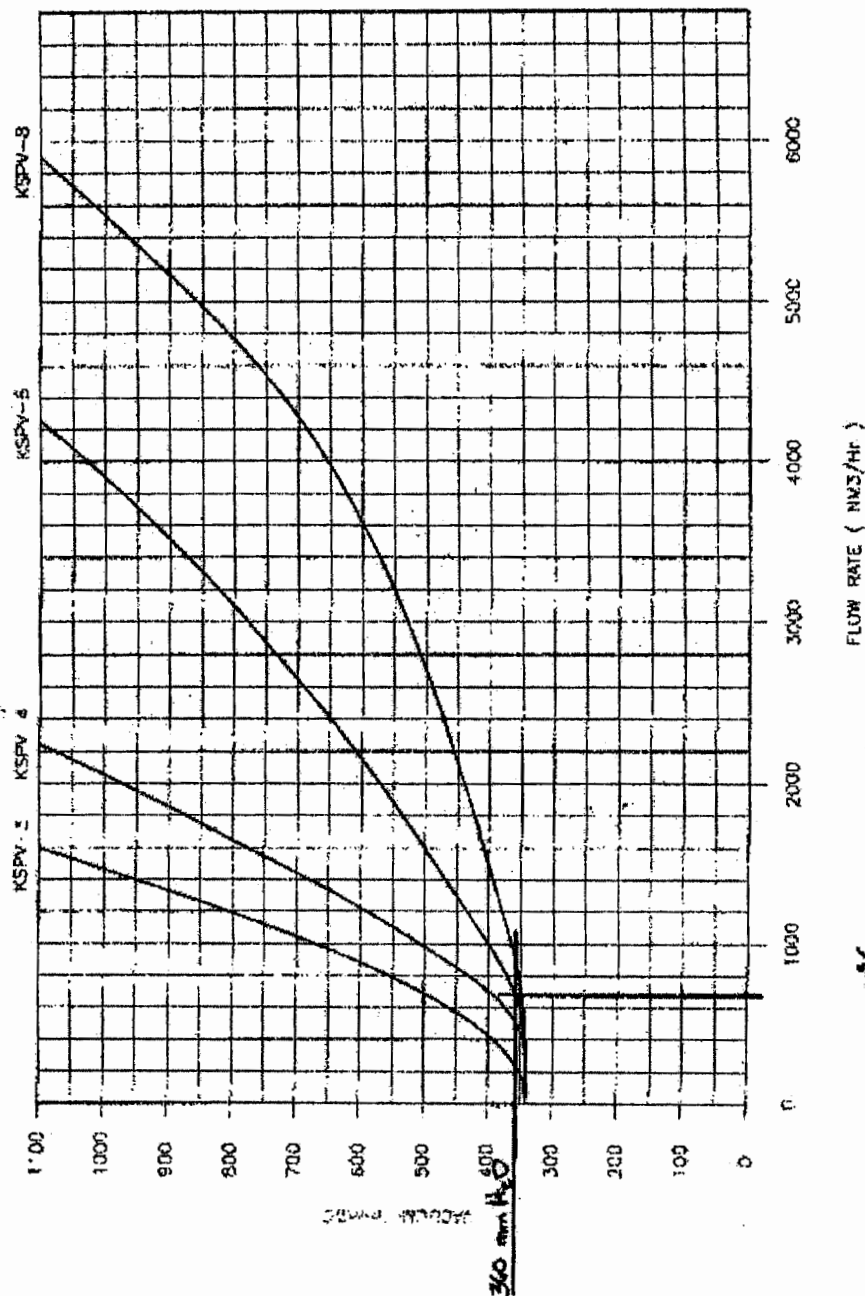
NEW JSD-JIV-series flow capacity curve

FILE POSITION : PC02/02/01/flow.doc

CONRAD C-994 THRU C-997

# FLOW CAPACITY CURVE GRAPH

FLOW TEST PERFORMED ON EQUIPMENT  
USING AIR, AT TEMP. T=15.6°C AND  
AMBIENT PRESSURE P=1.0332 KG/CM2.



$$4800 \text{ m}^3/\text{hr} \times \frac{1 \text{ m}^3/\text{hr}}{6.289} = 684 \text{ m}^3/\text{hr}$$

$$360 \text{ mm H}_2\text{O} \times \frac{0.0143 \text{ psi}}{\text{mm H}_2\text{O}} = 0.51 \text{ psi}$$

TANKTECH

TYPE HIGH VELOCITY VACUUM RELIEF VALVE  
KSPV TYPE



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

Coast Guard Approval Number: 162.017/144/3

Expires: 17 March 2016

**PRESSURE-VACUUM RELIEF VALVES FOR TANK VESSELS**

TANKTECH CO., LTD.  
#1506-2 SONGJEONG-DONG  
GANGSEO-GU  
BUSAN 618-270  
KORBA, REPUBLIC OF

Model KLPH-6 ND 150 high velocity pressure/vacuum relief valves. AISI 304 Stainless steel, wt.-loaded construction.

Identifying Data: Drwg: KSP #PHZZ3000 dtd. Nov 04, 1995, Korea Inst. of Mach. & Metals Test report #s 95139250, 95139250-1, 95139250-2, & 95139250- 3, dtd. August 7, 1995 and report dated December 19, 2000.

Pressure setting: 700-2100 mm H2O (1-3 psig), Vacuum setting: 344 mm H2O (0.5 psig).

This certificate supersedes approval number 162.017/144/2, dated January 28, 2006.

\*\*\* 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 17<sup>th</sup> DAY OF  
MARCH 2011, AT WASHINGTON D.C.

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