South Coast Air Quality Management District

Supplemental Instructions

For

Liquid Organic Storage Tanks

Annual Emissions Reporting Program

October 2019

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INTRODUCTION

The purpose of this supplemental manual is to provide facilities instructions for estimating emissions from liquid organic storage tanks.

Storage tanks containing organic liquids can be found in many industries, including:

- petroleum production and refining,
- petrochemical and chemical manufacturing,
- bulk storage and transfer operations, and
- other industries consuming organic liquids.

Organic liquids in the petroleum industry, usually called petroleum products, generally are mixtures of hydrocarbons having different true vapor pressures (for example, gasoline and crude oil). Organic liquids in the chemical industry are composed of pure chemicals or mixtures of chemicals with similar true vapor pressures (for example, benzene or a mixture of isopropyl and butyl alcohol).

Typically, liquid organic storage tanks are categorized in two types: floating roof and fixed roof. There are five basic designs for organic liquid storage tanks:

- ♦ external floating roof,
- ♦ internal floating roof,
- ♦ above-ground vertical fixed roof,
- ♦ above-ground horizontal fixed roof, and
- ♦ underground fixed roof tank

Tank emissions associated with each design are briefly described here. Detailed descriptions and emission calculation procedures for each tank design are provided in Chapter 7 of EPA's Compilation of Air Pollutant Emission Factors (AP-42).

The scope of this manual is to provide users a simple procedure to calculate emissions from storage tanks. The methodologies presented in AP-42 are simplified based on the assumptions and conditions applicable to the South Coast Air Basin to assist users to calculate and report tank emissions in the Annual Emission Reporting (AER) web-based reporting tool.

Facilities are encouraged to calculate and report tank emissions using U. S. Environmental Protection Agency's (US EPA) "TANKS" software program. The results from TANKS calculation can then be imported to the AER Reporting Tool.

TANKS is a Windows-based computer software program that estimates volatile organic compound (VOC) and hazardous air pollutant (HAP) emissions from fixed- and floating-roof storage tanks. The TANKS program employs a chemical database of over 100 organic liquids, and a meteorological database of over 240 cities in the United States. The program allows the addition of more chemicals and cities, if desired. TANKS is capable of calculating individual component emissions from known mixtures and estimating emissions from crude oils and selected refined petroleum products using liquid

concentration HAP profiles supplied with the program. The TANKS program is based on the emission estimation procedures from Chapter 7 of EPA's Compilation of Air Pollutant Emission Factors (AP-42). The user's manual explains the many features and options of TANKS. To get a copy of TANKS, please contact Info CHIEF at (919) 541-1000, or visit the US EPA's website. Note: The EPA TANKS model was developed using a software that is now outdated. Because of this, the model is not reliably functional on computers using certain operating systems such as Windows Vista or Windows 7. Additionally, the EPA no longer provides technical support to users of TANKS. For more detailed information, visit the EPA TANKS website at: https://www3.epa.gov/ttnchie1/software/tanks/

EXTERNAL FLOATING ROOF TANKS

A typical external floating roof tank consists of an open-topped cylindrical steel shell equipped with a roof that floats on the surface of the stored liquid. The floating roof consists of a deck, fittings, and rim seal system. Floating decks that are currently in use are constructed of welded steel plate and are of two general types: pontoon or double-deck. With all types of external floating roof tanks, the roof rises and falls with the liquid level in the tank. External floating decks are equipped with a rim seal system, which is attached to the deck perimeter and contacts the tank wall. The purpose of the floating roof and rim seal system is to reduce evaporative loss of the stored liquid. Some annular space remains between the seal system and the tank wall. The seal system slides against the tank wall as the roof is raised and lowered. The floating deck is also equipped with fittings that penetrate the deck and serve operational functions. The external floating roof design is such that evaporative losses from the stored liquid are limited to losses from the rim seal system and deck fittings (standing storage loss) and any exposed liquid on the tank walls (working loss).

INTERNAL FLOATING ROOF TANKS

An internal floating roof tank has both a permanent fixed roof and a floating roof inside. There are two basic types of internal floating roof tanks: tanks in which the fixed roof is supported by vertical columns within the tank, and tanks with a self-supporting fixed roof and no internal support columns. Fixed roof tanks that have been retrofitted to use a floating roof are typically of the first type. External floating roof tanks that have been converted to internal floating roof tanks typically have a self-supporting roof. Newly constructed internal floating roof tanks may be of either type. The deck in internal floating roof tanks rises and falls with the liquid level and either floats directly on the liquid surface (contact deck) or rests on pontoons several inches above the liquid surface (non-contact deck). The majority of aluminum internal floating roofs currently in service have non-contact decks.

FIXED ROOF TANKS

A typical vertical fixed roof tank consists of a cylindrical steel shell with a permanently affixed roof, which may vary in design from cone- or dome-shaped to flat. Losses from fixed roof tanks are caused by changes in temperature, pressure, and liquid level.

Fixed roof tanks are either freely vented or equipped with a pressure/vacuum vent. The latter allows the tanks to operate at a slight internal pressure or vacuum to prevent the release of vapors during very small changes in temperature, pressure, or liquid level. Of current tank designs, the fixed roof tank is the least expensive to construct and is generally considered the minimum acceptable equipment for storing organic liquids.

Horizontal fixed roof tanks are constructed for both above-ground and underground service and are usually constructed of steel, steel with a fiberglass overlay, or fiberglass-reinforced polyester. Horizontal tanks are generally small storage tanks with capacities of less than 40,000 gallons. Horizontal tanks are constructed such that the length of the tank is not greater than six times the diameter to ensure structural integrity.

The potential emission sources for above-ground horizontal tanks are the same as those for vertical fixed roof tanks. Emissions from underground storage tanks are associated mainly with changes in the liquid level in the tank. Losses due to changes in temperature or barometric pressure are minimal for underground tanks because the surrounding earth limits the diurnal temperature change, and changes in the barometric pressure result in only small losses.

EMISSIONS

Emissions from organic liquids storage tanks occur because of evaporative loss of the liquid during its storage and as a result of changes in the liquid level.

Emissions from fixed roof tanks are a result of evaporative losses during storage (known as breathing losses or standing storage losses) and evaporative losses during filling and emptying operations (known as working losses).

Storage loss is the expulsion of vapor from a tank through vapor expansion and contraction, which are the results of changes in temperature and barometric pressure. This loss occurs without any liquid level change in the tank.

The combined loss from filling and emptying is called working loss. Evaporation during filling operations is a result of an increase in the liquid level in the tank. As the liquid level increases, the pressure inside the tank exceeds the relief pressure and vapors are expelled from the tank. Evaporative loss during emptying occurs when air drawn into the tank during liquid removal becomes saturated with organic vapor and expands, thus exceeding the capacity of the vapor space.

For floating roof tanks, standing storage losses are a result of evaporative losses through rim seals, deck fittings, including deck seams losses, in case of internal floating roof tanks, for construction other than welded decks.

Withdrawal losses occur as the liquid levels, and thus the floating roof is lowered. Some liquid remains on the inner tank wall surface and evaporates. For an internal floating roof tank that has a column supported fixed roof, some liquid also clings to the columns and evaporates. Evaporative loss occurs until the tank is filled and the exposed surfaces are again covered.

ASSUMPTIONS

The calculation methodologies provided in this document are the simplified versions of

those outlined in the AP-42. This simplification is needed to assist users who choose to calculate and report tank emissions directly into the AER Reporting Tool, and based on the following assumptions:

- average ambient temperature: 520 degree R
- daily ambient temperature range: 17.9 degree R
- atmospheric pressure: 14.7 psia
- tank color: white
- shell condition: light rust
- other default parameters assumed in the EPA AP-42 document

Other parameters needed for calculating emissions from storage tanks are tabulated in Appendix 1 and 2. Appendix 1 contains parameters associated with the properties of the stored material such as vapor or liquid molecular weights and true vapor pressure. Appendix 2 provides parameters associated with the diameter of the storage vessel for different types of tanks. From minimal process data such as tank type, size, and type of stored material, users can look up related parameters in the appendices, fill in the forms, and calculate emissions. This manual also provides an alternative emissions calculation for underground liquid fuel and above-ground small tanks (less than 10,000 gallons capacity). Some parameters are modified to accommodate special cases such as horizontal, square, or rectangular tanks. Emissions of toxic air contaminants or other components of stored liquid mixture can also be calculated using equation 18.

Line-by-line instructions and examples for using the EPA TANKS software and importing data into the AER Reporting Tool may be found in the “Guidelines for Working with EPA TANKS Data with the New AER System.”

EMISSIONS FROM FLOATING ROOF TANKS

Total emissions or losses from floating roof tanks may be calculated using the following equation:

$$L_T = L_W + L_R + L_F + L_D + L_X \qquad \textit{(Eq. 1)}$$

where:

L_T = total loss, lbs/yr

L_W = working loss, lbs/yr

L_R = rim seal loss, lbs/yr

L_F = deck fitting loss, lbs/yr

L_D = deck seam loss, lbs/yr *(applicable to internal floating roof tanks only)*

L_X = loss from process upset, lbs/yr

Working Loss - The working loss from floating roof tanks can be estimated using Equation 2.

$$L_W = (1 - N_C) * \left(\frac{22.45 * Q * S_C * W_L}{D} \right) \qquad (Eq. \ 2)$$

where:

L_W = working loss, lbs/yr

N_C = roof support factor, dimensionless

For **external** floating roof tank, N_C = 0

For **internal** floating roof tanks, depending on tank diameter

[See Appendix 2 for selected roof support factors].

Q = annual throughput in units of 1,000 gallons, Mgal/yr

S_C = shell clinage factor is defined as follows:

S_C = 0.006 for **crude oil**

S_C = 0.0015 for **other materials**

W_L = average organic liquid density, lbs/gal

[See Appendix 1 for average organic liquid density of selected materials].

D = tank diameter, ft

Rim Seal Loss - Rim seal loss from floating roof tanks can be estimated using the following equation:

$$L_R = K_R * D * F_P * M_V * K_C \qquad (Eq. \ 3)$$

where:

L_R = rim seal loss, lbs/yr

K_R = rim seal loss factor, lb-mole/ft-yr, is defined as:

K_R = 20.1 for **external** floating roof tanks

K_R = 6.7 for **internal** floating roof tanks.

D = tank diameter, ft

F_P = vapor pressure function, dimensionless

[See Appendix 1 for vapor pressure function of selected materials]

M_V = average vapor molecular weight, lb/lb-mole

[See Appendix 1 for vapor molecular weight of selected materials]

K_C = product factor; K_C = 0.4 for **crude oil**; K_C = 1 for all **other materials**

Deck Fitting Loss - Deck fitting loss from floating roof tanks can be estimated using the following equation:

$$L_F = F_F * F_P * M_V * K_C \qquad (Eq.\ 4)$$

where:

L_F = deck fitting loss, lb/yr

F_F = total deck fitting loss factor, lb-mole/yr, depending on tank diameter and type of roof deck.

[See Appendix 2 for selected deck fitting loss factors].

F_P = vapor pressure function, dimensionless

[See Appendix 1 for vapor pressure function of selected materials]

M_V = average vapor molecular weight, lb/lb-mole

[See Appendix 1 for vapor molecular weight of selected materials]

K_C = product factor; K_C = 0.4 for **crude oil**; K_C = 1 for all **other materials**

Deck Seam Loss - Deck seam loss, L_D, is applicable only to **internal floating roof tanks with bolted decks** and can be estimated by the following equation:

$$L_D = S_D * K_D * D^2 * F_P * M_V * K_C \qquad (Eq.\ 5)$$

where:

L_F = deck seam loss, lbs/yr

S_D = deck seam length factor, ft/ft^2

for bolted deck S_D = 0.2

for others S_D = 0.0

K_D = deck seam loss per unit seam length factor, lb-mole/ft-yr

for bolted deck K_D = 0.14

for others K_D = 0.0

D = tank diameter, ft

Fp = vapor pressure function, dimensionless

[See Appendix 1 for vapor pressure function of selected materials]

M_V = average vapor molecular weight, lb/lb-mole

[See Appendix 1 for vapor molecular weight of selected materials]

K_C = product factor; K_C = 0.4 for **crude oil**; K_C = 1 for all **other materials**

EMISSIONS FROM FIXED ROOF TANKS

Total emissions or losses from fixed roof tanks are equal to the sum of the working loss and standing loss:

$$L_T = L_W + L_S + L_X \qquad \textit{(Eq. 6)}$$

where:

L_T = total loss, lbs/yr

L_W = working loss, lbs/yr

L_S = standing loss, lbs/yr

L_X = loss from process upset, lbs/yr

Working Loss - The working loss from fixed roof tanks can be estimated from:

$$L_W = 0.024 * M_V * P_{VA} * Q * K_N * K_P \qquad (Eq.\ 7)$$

where:

L_W = working loss, lbs/yr

M_V = average vapor molecular weight, lb/lb-mole

[See Appendix 1 for vapor molecular weight of selected materials]

P_{VA} = true vapor pressure of stored liquid at average liquid surface temperature, psia

[See Appendix 1 for true vapor pressure of selected materials]

Q = annual throughput, Mgallon/yr

K_N = turn over factor, dimensionless, dependent of annual throughput, Q

(Mgallon/yr), and tank capacity, *C (Mgallons)*. K_N is calculated as follows:

If $Q/C \leq 36$ then $K_N = 1.0$

If $Q/C > 36$ then

$$K_N = \frac{180 * C + Q}{6 * Q} \qquad (Eq.\ 8)$$

K_P = working loss product factor, dimensionless, K_P = 0.75 for **crude oil** and K_P = 1.0 for **other materials**

Standing Loss - Fixed roof tank standing loss can be estimated from:

$$L_S = U * V_V * W_V * K_E * K_S \qquad (Eq.\ 9)$$

where:

L_S = standing storage loss, lbs/yr

U = number of days of the year that the tank is used to store liquid material. This number must not be more than 365 days. If not known, assume 365 days.

V_V = vapor space volume can be calculated as:

$$V_V = 66.84 * C + V_F \qquad (Eq.\ 10)$$

where:

C = tank capacity, Mgallons

V_F = vapor space function, depending on tank diameter

[See Appendix 2 for selected vapor space function]

W_V = vapor density, lb/ft^3

[See Appendix 1 for vapor density of selected materials]

K_E = vapor space expansion factor, dimensionless

[See Appendix 1 for vapor space expansion factors for selected materials]

K_S = vented vapor saturation factor, dimensionless, can be calculated as follows:

$$K_S = \frac{1}{1+(S_A * H)+(S_B * D)} \qquad (Eq.\ \ 11)$$

where:

S_A, S_B = vapor saturation functions

[See Appendix 1 for vapor saturation function of selected materials]

D = tank diameter, ft

H = tank height, ft

SPECIAL CASES

For **horizontal tank** :

$$V_V = \frac{H * D^2}{2} \qquad (Eq.\ \ 10-a)$$

and

$$K_S = \frac{1}{1+(0.0265 * P_{VA} * D)} \qquad (Eq.\ \ 11-a)$$

$$V_V = \frac{0.393 * H * L_1 * L_2}{(L_1 + L_2)} \qquad (Eq.\ \ 10-b)$$

For **rectangular tank**:

and

where:

$$K_S = \frac{1}{1+(0.0133 * P_{VA} * H)} \qquad (Eq.\ \ 11-b)$$

L_1 , L_2 = side 1 and side 2 of rectangular tank, ft

D = tank diameter, ft

H = tank height, ft

P_{VA} = true vapor pressure of stored liquid at average liquid surface temperature, psia

[See Appendix 1 for true vapor pressure of selected materials]

UNDERGROUND STORAGE TANKS

For underground tanks, assume that no breathing or standing losses occur (L_S = 0) because the insulating nature of the earth limits the temperature change. Underground tank is classified as fixed roof tank, users can use Equation 7 to estimate working loss (total loss) for underground storage tanks.

For **service stations where fuels (gasoline and diesel)** are transferred and dispensed, VOC emissions may be estimated and reported using emission factors established by the California Air Resources Board (CARB). The CARB emission factor includes losses from Loading, Storing, Dispensing, and Spills or Leaks from all components of the transfer and dispensing facility:

For Gasoline:

Underground Gasoline Tanks:

VOC EF = 0.843 lb/1000 gals. (controlled)

Toxics Emissions:

- Benzene: 0.003993 lb/1000 gals
- Ethylbenzene: 0.003638 lb/1000 gals

Above-ground Tanks:

VOC EF = 0.921 lb/1000 gals. (controlled)

Toxics Emissions:

- Benzene: 0.00921 lb/1000 gals
- Naphthalene: 0.00129 lb/1000 gals

For Diesel:

VOC EF = 0.0028 lb/1000 gals. (controlled)

SMALL LIQUID STORAGE TANKS

Small liquid storage tank is defined as tank with ***storage capacity of less than 10,000 gallons and operated at ambient temperature and pressure***. Total emissions or losses from small tanks (similar to fixed roof tanks) are equal to the sum of the working loss and standing loss:

$$L_T = L_W + L_S \qquad (Eq.\ 13)$$

where:

L_T = total loss, lbs/yr

L_W = working loss, lbs/yr

L_S = standing loss, lbs/yr

Working Loss

$$L_W = f * Q \qquad (Eq.\ 14)$$

where:

L_W = working loss (lbs/year)

f = small tank filling loss factor, lbs/gal

[See Appendix 1 for filling loss factors of selected materials]

Q = annual throughput, Mgal/yr

Standing Loss

$$L_S = \frac{a * H * D^2}{[1 + (b * H)]} \qquad (Eq.\ 15)$$

where:

L_S = standing loss, lbs/yr

a, b = small tank standing loss factors

[See Appendix 1 for small tank loss factors of selected materials]

D* = tank diameter, ft

H = tank height, ft

* For **rectangular tank**, substitute D with the equivalent diameter (D_E) which is defined as:

$$D_E = \frac{2 * L_1 * L_2}{(L_1 + L_2)} \qquad (Eq.\ 16)$$

where:

L_1 = side 1 of rectangular tank (feet)

L_2 = side 2 of rectangular tank (feet)

For **square tank**, $L = L_1 = L_2$ then D_E becomes:

$$D_E = \frac{2 * L * L}{(L + L)} = L \qquad (Eq.\ 17)$$

where L = side of square tank (feet)

TOXIC AIR CONTAMINANT (TAC) CALCULATION

Toxic air contaminant emissions associated with storage tanks must be calculated and reported. In general, the emission rate for each component can be estimated by:

$$L_{TAC} = Z_{TAC} * L_T \qquad (Eq.\ 18)$$

where:

L_{TAC} = emission rate of TAC component, lbs/yr

Z_{TAC} = weight fraction of TAC component

[See Appendix 3 for TAC weight fraction profile of selected petroleum products]

L_T = total losses, lbs/yr

For products containing numerous TAC components, it's advantageous to utilize EPA's TANKS program to calculate emissions for each TAC component. One of the key features of TANKS program is the ability to build and store the speciation profile (weight

fraction of TAC components) of the mixture. The results from TANKS (both VOC and individual TAC emissions) can then be imported to the AER Reporting Tool. Otherwise, emissions for each TAC component must be calculated and reported individually in the Reporting Tool.

APPENDIX 1 - Properties and Parameters for Selected Materials

Product		Chemical Name	CAS	Vapor		Liquid Density	P_{VA}	F_P	K_E	S_A	S_B	Small Tank Loss Factors		
Category	Code			M_V	W_V	W_L						f	a	b
Crude Oils	001	Crude oil (RVP 5)		50	0.028	7.10	3.181	0.061	0.094	0.0843	0.0115	2.863	0.378	0.084
Petroleum Dist	002	Distillate fuel oil #2		130	0.00018	7.10	0.0077	0.00013	0.034	0.0002	0.00003	0.0241	0.0009	0.0002
Petroleum Dist	003	Residual oil #6		190	0.000002	7.90	0.00005	0.000001	0.034	0.000001	0.0000002	0.000241	0.00001	0.000001
Petroleum Dist	004	Jet naphtha (JP-4)		80	0.02	6.40	1.419	0.025	0.056	0.0376	0.0052	2.725	0.162	0.038
Petroleum Dist	005	Jet kerosene		130	0.0002	7.00	0.0098	0.00017	0.034	0.0003	0.00004	0.0306	0.0011	0.0003
Petroleum Dist	006	Gasoline (RVP 6)		69	0.04	5.60	3.275	0.063	0.091	0.0868	0.0119	5.423	0.522	0.087
Petroleum Dist	007	Gasoline (RVP 7)		68	0.047	5.60	3.880	0.076	0.106	0.1028	0.0141	6.332	0.714	0.103
Petroleum Dist	008	Gasoline (RVP 8)		68	0.054	5.60	4.494	0.091	0.118	0.1191	0.0163	7.334	0.918	0.119
Petroleum Dist	009	Gasoline (RVP 9)		67	0.061	5.60	5.116	0.107	0.134	0.1356	0.0186	8.226	1.171	0.136
Petroleum Dist	010	Gasoline (RVP 10)		66	0.067	5.60	5.744	0.123	0.143	0.1522	0.0209	9.099	1.379	0.152
Petroleum Dist	011	Gasoline (RVP 11)		65	0.074	5.60	6.379	0.141	0.174	0.1691	0.0232	9.952	1.835	0.169
Petroleum Dist	012	Gasoline (RVP 12)		64	0.08	5.60	7.020	0.161	0.199	0.1860	0.0255	10.783	2.272	0.186
Petroleum Dist	013	Gasoline (RVP 13)		62	0.084	5.60	7.667	0.182	0.229	0.2032	0.0278	11.408	2.764	0.203
Organic Liquids	014	Acetaldehyde	75070	44.0	0.106	6.58	13.568	0.566	2.542	0.3596	0.0493	14.328	38.608	0.360
Organic Liquids	015	Acetic acid	64197	60.1	0.0021	8.79	0.200	0.0034	0.039	0.0053	0.0007	0.289	0.012	0.005
Organic Liquids	016	Acetic anhydride	108247	102.1	0.0012	9.01	0.0650	0.0011	0.036	0.0017	0.0002	0.159	0.0060	0.0017
Organic Liquids	017	Acetone	67641	58.1	0.034	6.63	3.327	0.064	0.108	0.0882	0.0121	4.637	0.529	0.088
Organic Liquids	018	Acetonitrile	75058	41.1	0.0094	6.56	1.296	0.023	0.058	0.0343	0.0047	1.277	0.079	0.034
Organic Liquids	019	Acrylamide	79061	71.1	0.000001	9.36	0.00012	0.000002	0.034	0.000003	0.0000004	0.0002	0.000007	0.000003
Organic Liquids	020	Acrylic acid	79107	72.1	0.0007	8.86	0.0538	0.00092	0.035	0.0014	0.0002	0.0932	0.0035	0.0014
Organic Liquids	021	Acrylonitrile	107131	53.1	0.015	6.76	1.607	0.029	0.066	0.0426	0.0058	2.047	0.143	0.043
Organic Liquids	022	Allyl alcohol	107186	58.1	0.0033	7.13	0.324	0.0056	0.043	0.0086	0.0012	0.452	0.020	0.0086
Organic Liquids	023	Allyl chloride	107051	76.5	0.073	7.86	5.406	0.114	0.163	0.1433	0.0196	9.929	1.711	0.143
Organic Liquids	024	Aniline	62533	93.1	0.00013	8.53	0.0078	0.00013	0.034	0.0002	0.00003	0.0173	0.0006	0.0002
Organic Liquids	025	Benzene	71432	78.1	0.019	7.37	1.340	0.024	0.060	0.0355	0.0049	2.512	0.159	0.036
Organic Liquids	026	Butanol-(1)	71363	74.1	0.00093	6.76	0.0710	0.0012	0.036	0.0019	0.0003	0.126	0.0048	0.0019

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Category	Code			M_V	W_V	W_L						f	a	b
Organic Liquids	027	Butyl alcohol (-tert)	75650	74.1	0.0070	6.60	0.532	0.0092	0.049	0.0141	0.0019	0.945	0.049	0.014
Organic Liquids	028	Butyl chloride (-n)	109693	92.6	0.025	7.43	1.530	0.027	0.065	0.0405	0.0056	3.399	0.235	0.041
Organic Liquids	029	Carbon disulfide	75150	76.1	0.073	10.59	5.378	0.113	0.158	0.1425	0.0195	9.826	1.647	0.143
Organic Liquids	030	Carbon tetrachloride	56235	153.8	0.045	13.37	1.650	0.030	0.063	0.0437	0.0060	6.091	0.407	0.044
Organic Liquids	031	Chlorobenzene	108907	112.6	0.0032	9.24	0.158	0.0027	0.037	0.0042	0.0006	0.426	0.017	0.004
Organic Liquids	032	Chloroform	67663	119.4	0.059	12.49	2.778	0.052	0.093	0.0736	0.0101	7.959	0.785	0.074
Organic Liquids	033	Chloroprene	126998	88.5	0.049	8.05	3.100	0.059	0.098	0.0821	0.0113	6.587	0.683	0.082
Organic Liquids	034	Cresol (-m)	108394	108.1	0.00003	8.63	0.00180	0.000031	0.034	0.00005	0.00001	0.0047	0.00017	0.00005
Organic Liquids	035	Cresol (-o)	95487	108.1	0.00005	8.74	0.0024	0.000040	0.034	0.0001	0.00001	0.0061	0.00022	0.0001
Organic Liquids	036	Cresol (-p)	106445	108.1	0.00002	8.63	0.00086	0.000015	0.034	0.00002	0.000003	0.0022	0.00008	0.00002
Organic Liquids	037	Cyclohexane	110827	84.2	0.021	6.52	1.385	0.025	0.063	0.0367	0.0050	2.798	0.186	0.037
Organic Liquids	038	Cyclohexanol	108930	100.2	0.00004	8.03	0.0024	0.000041	0.034	0.0001	0.00001	0.0058	0.00021	0.00006
Organic Liquids	039	Cyclohexanone	108941	98.2	0.0011	7.91	0.0637	0.0011	0.035	0.0017	0.0002	0.150	0.0056	0.0017
Organic Liquids	040	Cyclohexene	110838	82.2	0.018	6.75	1.256	0.022	0.059	0.0333	0.0046	2.477	0.154	0.033
Organic Liquids	041	Cyclopentane	287923	70.1	0.059	6.25	4.709	0.096	0.138	0.1248	0.0171	7.925	1.163	0.125
Organic Liquids	042	Cyclopentanone	120923	84.1	0.0023	7.90	0.155	0.0027	0.037	0.0041	0.0006	0.314	0.012	0.004
Organic Liquids	043	Cyclopentene	142290	68.1	0.045	6.43	3.693	0.072	0.115	0.0979	0.0134	6.037	0.735	0.098
Organic Liquids	044	Decane (-n)	124185	142.3	0.0009	6.09	0.0375	0.00064	0.034	0.0010	0.0001	0.128	0.0047	0.0010
Organic Liquids	045	Dichloroethane (1,1)	75343	99.0	0.059	9.86	3.336	0.064	0.109	0.0884	0.0121	7.924	0.918	0.088
Organic Liquids	046	Dichloroethane (1,2)	107062	99.0	0.019	10.50	1.090	0.019	0.063	0.0289	0.0040	2.589	0.174	0.029
Organic Liquids	047	Dichloroethylene (cis-1,2)	540590	97.0	0.053	10.76	3.065	0.058	0.101	0.0812	0.0111	7.130	0.763	0.081
Organic Liquids	048	Dichloroethylene (-trans-1,2)	156605	97.0	0.084	10.52	4.877	0.100	0.152	0.1292	0.0177	11.348	1.828	0.129
Organic Liquids	049	Diethoxymethane		104.2	0.017	6.99	0.934	0.016	0.053	0.0248	0.0034	2.336	0.131	0.025
Organic Liquids	050	Diethyl (n,n) anilin	91667	149.2	0.0001	7.76	0.0022	0.00004	0.034	0.0001	0.00001	0.0077	0.0003	0.0001
Organic Liquids	051	Diethyl ether	60297	74.1	0.105	5.99	7.959	0.192	0.279	0.2109	0.0289	14.158	4.184	0.211
Organic Liquids	052	Diethyl ketone	96220	86.1	0.0072	6.78	0.472	0.0082	0.044	0.0125	0.0017	0.975	0.046	0.013
Organic Liquids	053	Diethyl sulfide	352932	90.2	0.013	6.97	0.808	0.014	0.050	0.0214	0.0029	1.749	0.093	0.021

APPENDIX 1 - Properties and Parameters for Selected Materials

Product		Chemical Name	CAS	Vapor		Liquid Density	P_{VA}	F_P	K_E	S_A	S_B	Small Tank Loss Factors		
Category	Code			M_V	W_V	W_L						f	a	b
Organic Liquids	054	Diethylamine	109897	73.1	0.044	5.91	3.365	0.065	0.121	0.0892	0.0122	5.906	0.760	0.089
Organic Liquids	055	Di-isopropyl ether	108203	102.2	0.044	6.08	2.437	0.045	0.084	0.0646	0.0088	5.974	0.529	0.065
Organic Liquids	056	Dimethyl formamide	68122	73.1	0.0006	7.58	0.0492	0.0008	0.035	0.0013	0.0002	0.086	0.003	0.001
Organic Liquids	057	Dimethyl hydrazine (1,1)	57147	60.1	0.023	7.88	2.185	0.040	0.082	0.0579	0.0079	3.151	0.275	0.058
Organic Liquids	058	Dimethyl phthalate	131113	194.2	0.00	9.97	0.00	0.00	0.034	0.00	0.00	0.00	0.0000	0.0000
Organic Liquids	059	Dioxane (1,4)	123911	88.1	0.008	8.66	0.510	0.0088	0.047	0.0135	0.0019	1.078	0.054	0.014
Organic Liquids	060	Dipropyl ether	111433	102.2	0.018	6.26	0.967	0.017	0.053	0.0256	0.0035	2.370	0.134	0.026
Organic Liquids	061	Di-t-butyl ether	6163662	130.2	0.017	6.40	0.743	0.013	0.048	0.0197	0.0027	2.321	0.118	0.020
Organic Liquids	062	Epichlorohydrin	106898	92.5	0.0037	9.85	0.227	0.0039	0.039	0.0060	0.0008	0.505	0.021	0.0060
Organic Liquids	063	Ethanolamine (mono-)	141435	61.1	0.00004	8.34	0.0033	0.00006	0.034	0.0001	0.00001	0.0048	0.0002	0.0001
Organic Liquids	064	Ethyl acetate	141786	88.1	0.02	7.55	1.309	0.023	0.062	0.0347	0.0048	2.768	0.183	0.035
Organic Liquids	065	Ethyl acrylate	140885	100.1	0.01	7.75	0.553	0.0096	0.046	0.0147	0.0020	1.330	0.065	0.015
Organic Liquids	066	Ethyl alcohol	64175	46.1	0.0064	6.61	0.780	0.014	0.052	0.0207	0.0028	0.862	0.047	0.021
Organic Liquids	067	Ethyl chloride	75003	64.5	0.210	7.68	18.357	0.312	0.038	0.4865	0.0666	28.425	1.145	0.486
Organic Liquids	068	Ethylamine	75047	45.1	0.126	5.69	15.778	0.268	0.038	0.4181	0.0573	17.070	0.688	0.418
Organic Liquids	069	Ethylbenzene	100414	106.2	0.0024	7.23	0.129	0.0022	0.037	0.0034	0.0005	0.329	0.013	0.0034
Organic Liquids	070	Ethylcyclopentane		98.2	0.010	6.38	0.550	0.0095	0.045	0.0146	0.0020	1.296	0.062	0.015
Organic Liquids	071	Ethyleneoxide	75218	44.0	0.155	7.23	19.802	0.337	0.038	0.5248	0.0719	20.911	0.842	0.525
Organic Liquids	072	Fluorobenzene	462066	96.1	0.018	8.52	1.076	0.019	0.055	0.0285	0.0039	2.482	0.145	0.029
Organic Liquids	073	Formic acid	64186	46.0	0.0049	10.18	0.600	0.010	0.046	0.0159	0.0022	0.662	0.032	0.016
Organic Liquids	074	Freon 11	75694	137.4	0.296	12.48	12.126	0.410	0.951	0.3213	0.0440	39.980	40.319	0.321
Organic Liquids	075	Furan	110009	68.1	0.108	7.82	8.919	0.229	0.374	0.2363	0.0324	14.573	5.779	0.236
Organic Liquids	076	Furfural	96011	96.1	0.0003	9.65	0.0175	0.0003	0.034	0.0005	0.0001	0.0404	0.0015	0.0005
Organic Liquids	077	Heptane (-n)	142825	100.2	0.011	5.73	0.638	0.011	0.048	0.0169	0.0023	1.534	0.077	0.017
Organic Liquids	078	Hexane (-n)	110543	86.2	0.033	5.53	2.177	0.040	0.078	0.0577	0.0079	4.501	0.372	0.058
Organic Liquids	079	Hexanol (-1)	111273	102.2	0.0002	6.76	0.0090	0.0002	0.034	0.0002	0.00003	0.022	0.0008	0.0002
Organic Liquids	080	Hydrogen cyanide	74908	27.0	0.053	5.77	11.084	0.337	0.668	0.2937	0.0402	7.191	5.094	0.294

APPENDIX 1 - Properties and Parameters for Selected Materials

Product		Chemical Name	CAS	Vapor		Liquid Density	P_{VA}	F_P	K_E	S_A	S_B	Small Tank Loss Factors		
Category	Code			M_V	W_V	W_L						f	a	b
Organic Liquids	081	Iso-butyl alcohol	78831	74.1	0.0029	6.71	0.222	0.0038	0.040	0.0059	0.0008	0.395	0.017	0.006
Organic Liquids	082	Isooctane	26635643	114.2	0.014	5.79	0.696	0.012	0.050	0.0184	0.0025	1.908	0.102	0.018
Organic Liquids	083	Isopentane	78784	72.2	0.144	5.20	11.268	0.348	0.756	0.2986	0.0409	19.511	15.639	0.299
Organic Liquids	084	Isoprene	78795	68.1	0.105	5.71	8.673	0.219	0.358	0.2298	0.0315	14.176	5.386	0.230
Organic Liquids	085	Isopropyl alcohol	67630	60.1	0.0061	6.57	0.576	0.010	0.047	0.0153	0.0021	0.830	0.042	0.015
Organic Liquids	086	Isopropyl benzene	98828	120.2	0.0013	7.21	0.0615	0.001	0.035	0.0016	0.0002	0.177	0.0067	0.0016
Organic Liquids	087	Methacrylonitrile	126987	67.1	0.012	6.74	1.015	0.018	0.055	0.0269	0.0037	1.634	0.095	0.027
Organic Liquids	088	Methyl acetate	79209	74.1	0.041	7.83	3.082	0.059	0.114	0.0817	0.0112	5.479	0.664	0.082
Organic Liquids	089	Methyl acrylate	96333	86.1	0.018	8.00	1.190	0.021	0.058	0.0315	0.0043	2.458	0.151	0.032
Organic Liquids	090	Methyl alcohol	67561	32.0	0.010	6.63	1.686	0.030	0.075	0.0447	0.0061	1.296	0.103	0.045
Organic Liquids	091	Methyl ethyl ketone	78933	72.1	0.016	6.75	1.256	0.022	0.055	0.0333	0.0046	2.173	0.127	0.033
Organic Liquids	092	Methyl isobutyl ketone	108101	100.2	0.0045	6.68	0.252	0.0043	0.040	0.0067	0.0009	0.605	0.026	0.007
Organic Liquids	093	Methyl methacrylate	80626	100.1	0.009	7.91	0.491	0.0085	0.047	0.0130	0.0018	1.179	0.059	0.013
Organic Liquids	094	Methyl propyl ether	557175	74.1	0.089	6.17	6.762	0.153	0.162	0.1792	0.0245	12.029	2.061	0.179
Organic Liquids	095	Methyl styrene (alpha)	98839	118.0	0.0006	7.59	0.0297	0.0005	0.035	0.0008	0.0001	0.084	0.0031	0.0008
Organic Liquids	096	Methylcyclohexane	108872	98.2	0.011	6.44	0.644	0.011	0.046	0.0171	0.0023	1.519	0.074	0.017
Organic Liquids	097	Methylcyclopentane	96377	84.2	0.030	6.27	1.976	0.036	0.071	0.0524	0.0072	3.992	0.302	0.052
Organic Liquids	098	Methyldichlorosilane		129.1	0.147	8.91	6.397	0.142	0.202	0.1695	0.0232	19.816	4.251	0.170
Organic Liquids	099	Methylene chloride	75092	84.9	0.095	11.12	6.334	0.140	0.193	0.1679	0.0230	12.912	2.636	0.168
Organic Liquids	100	Methyl-tert-butyl ether (MTBE)	1634044	88.2	0.057	6.20	3.665	0.072	0.113	0.0971	0.0133	7.754	0.931	0.097
Organic Liquids	101	Mineral Spirits		125.0	0.0005	5.92	0.023	0.0004	0.035	0.0006	0.0001	0.069	0.0025	0.0006
Organic Liquids	101	Morpholine	110918	87.1	0.0020	8.34	0.130	0.0022	0.037	0.0034	0.0005	0.271	0.011	0.003
Organic Liquids	102	Nitrobenzene	98953	123.1	0.0001	10.06	0.0029	0.00005	0.034	0.0001	0.0000	0.0087	0.0003	0.0001
Organic Liquids	103	Nitromethane	75525	61.0	0.005	9.54	0.426	0.0073	0.045	0.0113	0.0015	0.623	0.030	0.011
Organic Liquids	104	Nonane (-n)	111842	128.3	0.0017	5.99	0.0742	0.0013	0.035	0.0020	0.0003	0.228	0.0085	0.0020
Organic Liquids	105	n-Propyl nitrate	627134	105.1	0.0058	8.78	0.309	0.0053	0.041	0.0082	0.0011	0.778	0.034	0.008
Organic Liquids	106	o-Chlorotoluene	95498	126.6	0.001	9.02	0.0462	0.0008	0.035	0.0012	0.0002	0.140	0.0052	0.0012

APPENDIX 1 - Properties and Parameters for Selected Materials

Product		Chemical Name	CAS	Vapor		Liquid Density	P_{VA}	F_P	K_E	S_A	S_B	Small Tank Loss Factors		
Category	Code			M_V	W_V	W_L						f	a	b
Organic Liquids	107	Octane (-n)	111659	114.2	0.0034	5.87	0.167	0.0029	0.037	0.0044	0.0006	0.457	0.018	0.004
Organic Liquids	108	Pentachloroethane	76017	202.3	0.0015	13.95	0.0424	0.0007	0.035	0.0011	0.0002	0.206	0.0076	0.0011
Organic Liquids	109	Pentane (-n)	109660	72.2	0.098	5.25	7.631	0.181	0.257	0.2022	0.0277	13.213	3.593	0.202
Organic Liquids	110	Phosgene	75445	98.9	0.383	11.50	21.834	0.371	0.038	0.5786	0.0793	51.836	2.088	0.579
Organic Liquids	111	Picoline (-2)	108996	93.1	0.0024	7.93	0.145	0.0025	0.037	0.0038	0.0005	0.325	0.013	0.004
Organic Liquids	112	Propylamine (-n)	107108	59.1	0.049	6.03	4.704	0.096	0.141	0.1246	0.0171	6.673	1.000	0.125
Organic Liquids	113	Propylene glycol	57556	76.1	0.00002	8.65	0.00124	0.00002	0.034	0.00003	0.000005	0.0023	0.00008	0.00003
Organic Liquids	114	Propylene oxide	75669	58.1	0.078	7.17	7.571	0.179	0.295	0.2006	0.0275	10.558	3.304	0.201
Organic Liquids	115	Pyridine	110861	79.1	0.0039	8.16	0.275	0.0047	0.040	0.0073	0.0010	0.522	0.022	0.0073
Organic Liquids	116	Resorcinol	108463	110.1	0.000002	10.62	0.00010	0.000002	0.034	0.000003	0.0000004	0.0003	0.000009	0.000003
Organic Liquids	117	Styrene	100425	104.2	0.0016	7.56	0.085	0.0015	0.036	0.0023	0.0003	0.214	0.0081	0.0023
Organic Liquids	118	Tetrachloroethane (1,1,1,2)	630206	167.9	0.0047	13.34	0.157	0.0027	0.038	0.0042	0.0006	0.632	0.025	0.0042
Organic Liquids	119	Tetrachloroethane (1,1,2,2)	79345	167.9	0.0016	13.24	0.0528	0.0009	0.035	0.0014	0.0002	0.213	0.0080	0.0014
Organic Liquids	120	Tetrachloroethylene	127184	165.8	0.0072	13.55	0.243	0.0042	0.039	0.0065	0.0009	0.969	0.040	0.0065
Organic Liquids	121	Tetrahydrofuran	109999	72.1	0.030	7.42	2.322	0.043	0.081	0.0615	0.0084	4.019	0.347	0.062
Organic Liquids	122	Toluene	108883	92.1	0.0063	7.26	0.385	0.0066	0.042	0.0102	0.0014	0.852	0.038	0.010
Organic Liquids	123	Trichloro(1,1,2)trifluoroethane	76131	187.4	0.164	13.18	4.924	0.102	0.149	0.1305	0.0179	22.145	3.507	0.130
Organic Liquids	124	Trichloroethane (1,1,1)	71556	133.4	0.045	11.22	1.889	0.034	0.068	0.0501	0.0069	6.048	0.436	0.050
Organic Liquids	125	Trichloroethane (1,1,2)	79005	133.4	0.0068	11.16	0.289	0.0050	0.040	0.0077	0.0010	0.925	0.040	0.0077
Organic Liquids	126	Trichloroethylene	79016	131.4	0.022	12.27	0.950	0.017	0.055	0.0252	0.0034	2.996	0.174	0.025
Organic Liquids	127	Trichloropropane (1,2,3)	96184	147.4	3.925	11.58	149.998	2.55	0.038	3.9749	0.5446	530.740	21.380	3.975
Organic Liquids	128	Trimethylchorosilane		108.6	0.066	7.13	3.420	0.066	0.105	0.0906	0.0124	8.918	0.990	0.091
Organic Liquids	129	Vinyl acetate	108054	86.1	0.025	7.82	1.607	0.029	0.066	0.0426	0.0058	3.320	0.232	0.043
Organic Liquids	130	Vinylidene chloride	75354	96.5	0.155	10.38	9.039	0.234	0.359	0.2395	0.0328	20.935	7.963	0.240
Organic Liquids	131	Xylene (-m)	1330207	106.2	0.0020	7.24	0.108	0.0018	0.036	0.0029	0.0004	0.274	0.011	0.0029
Organic Liquids	132	Xylene (-o)	95476	106.2	0.002	7.35	0.085	0.0014	0.036	0.0022	0.0003	0.216	0.0082	0.0022
Organic Liquids	133	1,1-Diethoxyethane	105577	118.2	0.010	6.92	0.461	0.008	0.044	0.0122	0.0017	1.306	0.061	0.012

APPENDIX 1 - Properties and Parameters for Selected Materials

Product		Chemical Name	CAS	Vapor		Liquid Density	P_{VA}	F_P	K_E	S_A	S_B	Small Tank Loss Factors		
Category	Code			M_V	W_V	W_L						f	a	b
Organic Liquids	134	1,1-Dimethylcyclopentane		87.5	0.017	6.29	1.068	0.019	0.055	0.0283	0.0039	2.243	0.130	0.028
Organic Liquids	135	1,2,4-Trimethylbenzene	95636	120.2	0.0005	7.29	0.0249	0.00042	0.035	0.0007	0.0001	0.072	0.0026	0.0007
Organic Liquids	136	1,2-Dibromopropane	78751	201.9	0.0038	16.10	0.105	0.0018	0.036	0.0028	0.0004	0.509	0.020	0.0028
Organic Liquids	137	1,2-Diethylbenzene		134.2	0.0003	7.33	0.0117	0.0002	0.034	0.0003	0.00004	0.038	0.0014	0.0003
Organic Liquids	138	1,2-Dimethoxyethane	110714	90.1	0.039	7.22	2.446	0.045	0.085	0.0648	0.0089	5.291	0.476	0.065
Organic Liquids	139	1,2-Pentadiene		68.1	0.066	5.77	5.425	0.115	0.167	0.1438	0.0197	8.869	1.569	0.144
Organic Liquids	140	1,3-Dibromopropane	109648	201.9	0.0012	16.51	0.0330	0.00056	0.035	0.0009	0.0001	0.160	0.0059	0.0009
Organic Liquids	141	1,3-Diethylbenzene		134.2	0.0003	7.17	0.0128	0.0002	0.034	0.0003	0.00005	0.041	0.0015	0.0003
Organic Liquids	142	1,4-Diethylbenzene		134.2	0.0003	7.18	0.0119	0.0002	0.034	0.0003	0.00004	0.038	0.0014	0.0003
Organic Liquids	143	1,4-Pentadiene		68.1	0.135	5.49	11.132	0.340	0.672	0.2950	0.0404	18.199	12.965	0.295
Organic Liquids	144	1,5-Hexadiene		82.2	0.048	5.73	3.261	0.063	0.101	0.0864	0.0118	6.429	0.687	0.086
Organic Liquids	145	1-Chlorobutane	109639	92.6	0.024	7.38	1.444	0.026	0.063	0.0383	0.0052	3.207	0.213	0.038
Organic Liquids	146	1-Heptene		98.2	0.014	5.81	0.782	0.014	0.050	0.0207	0.0028	1.842	0.097	0.021
Organic Liquids	147	1-Methyl-2-isopropylbenzene	527844	134.2	0.0004	7.30	0.0173	0.00029	0.034	0.0005	0.0001	0.056	0.0020	0.0005
Organic Liquids	148	1-Octanol	111875	130.2	0.00002	6.89	0.00108	0.00002	0.034	0.00003	0.000004	0.0034	0.0001	0.00003
Organic Liquids	149	1-Pentene	109671	70.1	0.120	5.33	9.662	0.261	0.430	0.2560	0.0351	16.265	7.411	0.256
Organic Liquids	150	1-Pentyne		68.1	0.077	5.76	6.366	0.141	0.208	0.1687	0.0231	10.408	2.294	0.169
Organic Liquids	151	1-Propanethiol		76.2	0.030	7.01	2.210	0.041	0.079	0.0586	0.0080	4.040	0.337	0.059
Organic Liquids	152	1-Propanol	71238	60.1	0.0027	6.70	0.257	0.0044	0.041	0.0068	0.0009	0.371	0.016	0.0068
Organic Liquids	153	2,2,3-Trimethylpentane		114.2	0.0089	5.97	0.439	0.0076	0.043	0.0116	0.0016	1.204	0.055	0.012
Organic Liquids	154	2,2,4-Trimethylpentane	540841	114.2	0.014	5.76	0.687	0.0120	0.048	0.0182	0.0025	1.884	0.095	0.018
Organic Liquids	155	2,2-Dimethylpentane		100.2	0.027	5.61	1.501	0.027	0.063	0.0398	0.0054	3.609	0.242	0.040
Organic Liquids	156	2,3,3-Trimethylpentane		114.2	0.0075	6.05	0.369	0.0063	0.041	0.0098	0.0013	1.011	0.044	0.010
Organic Liquids	157	2,3-Dimethylbutane		86.2	0.053	5.51	3.444	0.067	0.105	0.0913	0.0125	7.124	0.792	0.091
Organic Liquids	158	2,3-Dimethylpentane		100.2	0.017	5.79	0.966	0.017	0.053	0.0256	0.0035	2.324	0.131	0.026
Organic Liquids	159	2,3-Pentadiene		68.1	0.057	5.79	4.690	0.096	0.143	0.1243	0.0170	7.668	1.166	0.124
Organic Liquids	160	2,4-Dimethylpentane		100.2	0.030	5.60	1.661	0.030	0.066	0.0440	0.0060	3.994	0.280	0.044

APPENDIX 1 - Properties and Parameters for Selected Materials

Product		Chemical Name	CAS	Vapor		Liquid Density	P_{VA}	F_P	K_E	S_A	S_B	Small Tank Loss Factors		
Category	Code			M_V	W_V	W_L						f	a	b
Organic Liquids	161	2-Chlorobutane	78864	92.6	0.037	7.27	2.275	0.042	0.079	0.0603	0.0083	5.055	0.422	0.060
Organic Liquids	162	2-Methyl-1-butene		70.1	0.062	5.42	4.958	0.102	0.136	0.1314	0.0180	8.345	1.203	0.131
Organic Liquids	163	2-Methylhexane		100.2	0.016	5.66	0.920	0.016	0.052	0.0244	0.0033	2.212	0.123	0.024
Organic Liquids	164	2-Methylpentane		86.2	0.047	5.44	3.086	0.059	0.097	0.0818	0.0112	6.384	0.658	0.082
Organic Liquids	165	2-Propanethiol		76.2	0.055	6.83	4.054	0.080	0.123	0.1074	0.0147	7.410	0.967	0.107
Organic Liquids	166	3,3-Dimethylpentane		100.2	0.021	5.78	1.176	0.021	0.057	0.0312	0.0043	2.828	0.170	0.031
Organic Liquids	167	3,4-Dichlorotoluene		161.0	0.0001	10.47	0.0037	0.0001	0.034	0.0001	0.00001	0.014	0.0005	0.0001
Organic Liquids	168	3-Ethylpentane		100.2	0.014	5.82	0.808	0.014	0.050	0.0214	0.0029	1.942	0.103	0.021
Organic Liquids	169	3-Methylhexane		100.2	0.015	5.72	0.858	0.015	0.051	0.0227	0.0031	2.063	0.112	0.023
Organic Liquids	170	Trimethylphosphite		124.0	0.005	8.72	0.220	0.004	0.039	0.0058	0.0008	0.655	0.027	0.006
Organic Liquids	171	MAA		116.1	0.0004	9.01	0.017	0.0003	0.034	0.0005	0.0001	0.047	0.0017	0.0005
Organic Liquids	172	Chloral		147.4	0.0106	12.59	0.4040	0.0070	0.043	0.0107	0.0015	1.429	0.065	0.0107
Organic Liquids	173	Monomethylamine 50%		31.1	0.034	5.50	6.207	0.136	0.266	0.1645	0.0225	4.627	1.306	0.164
Organic Liquids	174	Dimethylamine 40%		45.1	0.0200	7.51	2.496	0.046	0.099	0.0661	0.0091	2.700	0.283	0.066
Organic Liquids	175	Dichlorvos		221.0	0.000275	11.88	0.00700	0.000119	0.034	0.000186	0.0000254	0.0371	0.001	0.000186
Organic Liquids	176	Dicrotophos		237.2	0.0093	10.17	0.2200	0.00377	0.039	0.0058	0.0008	1.2525	0.051	0.0058
Organic Liquids	177	Metam Sodium		129.2	0.000	10.09	0.001	0.000	0.034	0.0000	0.0000	0.003	0.00011	0.00003
Organic Liquids	178	Dimethylchloroacetoacetate		149.5	0.0121	10.01	0.456	0.0079	0.044	0.0121	0.0017	1.636	0.076	0.0121
Organic Liquids	179	Dimethylformamide		73.1	0.006	8.34	0.456	0.008	0.044	0.0121	0.0017	0.800	0.037	0.012
Organic Liquids	180	Nitrochlorobenzene		157.56	0.00003	10.79	0.00100	0.00002	0.034	0.0000	0.00000	0.0038	0.0001	0.00003
Organic Liquids	181	Aromatic 150 Fluid	64742945	142.00	0.01233	7.50	0.48900	0.00846	0.045	0.0130	0.00178	1.6665	0.079	0.01296
Organic Liquids	182	Texanol	25265774	216.40	0.00005	7.92	0.00132	0.00002	0.034	0.0000	0.00000	0.0068	0.0002	0.00003
Organic Liquids	183	Morpholine	110918	87.12	0.0020	8.34	0.12980	0.0022	0.037	0.0034	0.0005	0.271	0.011	0.003
Organic Liquids	184	Naphthalene	91203	128.20	0.00006	11.08	0.00248	0.0000	0.034	0.0001	0.0000	0.008	0.0003	0.00007
Other Liquids	185	Ammonia	1336216	17.03	0.02719	7.49	8.99408	0.2323	0.535	0.2383	0.03265	3.676	2.084	0.23834
Organic Liquids	186	Ethylene Glycol Monobutyl Ether	111762	118.18	0.00032	7.51	0.01547	0.0003	0.034	0.0004	0.00006	0.044	0.002	0.00041
Organic Liquids	187	Ethylene Glycol	107211	62.07	0.00007	9.31	0.00628	0.0001	0.034	0.0002	0.00002	0.009	0.0003	0.00017

APPENDIX 2 - Storage Tank Factors by Diameter

TANK DIAMETER (ft)	FLOATING											FIXED ROOF
	External Roof					Internal Roof						
			F_F					F_F		K_D	S_D	
	N_C	K_R	Pontoon	Double	K_D	N_C	K_R	Bolted	Welded	Bolted	Bolded	V_F
10	0.0	20.1	1628.6	1634.5	0.0	0.100	6.7	245.5	244.5	0.14	0.2	54
12	0.0	20.1	1630.2	1634.8	0.0	0.083	6.7	245.3	243.9	0.14	0.2	93
14	0.0	20.1	1631.8	1635.1	0.0	0.071	6.7	245.6	243.7	0.14	0.2	148
16	0.0	20.1	1633.4	1635.5	0.0	0.063	6.7	246.4	243.9	0.14	0.2	220
18	0.0	20.1	1635.1	1635.8	0.0	0.056	6.7	247.6	244.5	0.14	0.2	314
20	0.0	20.1	1636.8	1636.2	0.0	0.050	6.7	249.3	245.5	0.14	0.2	430
22	0.0	20.1	1638.5	1636.6	0.0	0.045	6.7	251.5	246.8	0.14	0.2	573
24	0.0	20.1	1640.2	1637.1	0.0	0.042	6.7	254.1	248.6	0.14	0.2	744
26	0.0	20.1	1641.9	1637.6	0.0	0.038	6.7	257.2	250.8	0.14	0.2	946
28	0.0	20.1	1643.7	1638.1	0.0	0.036	6.7	260.8	253.3	0.14	0.2	1181
30	0.0	20.1	1645.5	1638.7	0.0	0.033	6.7	264.9	256.2	0.14	0.2	1453
32	0.0	20.1	1647.3	1639.2	0.0	0.031	6.7	269.4	259.6	0.14	0.2	1763
34	0.0	20.1	1649.1	1639.8	0.0	0.029	6.7	274.4	263.3	0.14	0.2	2115
36	0.0	20.1	1650.9	1640.5	0.0	0.028	6.7	279.9	267.4	0.14	0.2	2510
38	0.0	20.1	1652.8	1641.2	0.0	0.026	6.7	285.8	271.9	0.14	0.2	2952
40	0.0	20.1	1654.7	1641.9	0.0	0.025	6.7	292.2	276.9	0.14	0.2	3443
42	0.0	20.1	1656.6	1642.6	0.0	0.024	6.7	299.1	282.2	0.14	0.2	3986
44	0.0	20.1	1658.5	1643.4	0.0	0.023	6.7	306.4	287.9	0.14	0.2	4583
46	0.0	20.1	1660.4	1644.2	0.0	0.022	6.7	314.3	293.9	0.14	0.2	5237
48	0.0	20.1	1662.4	1645.0	0.0	0.021	6.7	322.5	300.4	0.14	0.2	5950
50	0.0	20.1	1664.4	1645.8	0.0	0.020	6.7	331.3	307.3	0.14	0.2	6725

APPENDIX 2 - Storage Tank Factors by Diameter

TANK DIAMETER (ft)	FLOATING											FIXED ROOF
	External Roof					Internal Roof						
			F_F					F_F		K_D	S_D	
	N_C	K_R	Pontoon	Double	K_D	N_C	K_R	Bolted	Welded	Bolted	Bolded	V_F
52	0.0	20.1	1666.4	1646.7	0.0	0.019	6.7	340.5	314.6	0.14	0.2	7565
54	0.0	20.1	1668.4	1647.6	0.0	0.019	6.7	350.2	322.2	0.14	0.2	8472
56	0.0	20.1	1670.4	1648.6	0.0	0.018	6.7	360.4	330.3	0.14	0.2	9448
58	0.0	20.1	1672.5	1649.6	0.0	0.017	6.7	371.0	338.7	0.14	0.2	10497
60	0.0	20.1	1674.5	1650.6	0.0	0.017	6.7	382.1	347.6	0.14	0.2	11621
62	0.0	20.1	1676.6	1651.6	0.0	0.016	6.7	393.7	356.8	0.14	0.2	12822
64	0.0	20.1	1678.7	1652.7	0.0	0.016	6.7	405.8	366.5	0.14	0.2	14103
66	0.0	20.1	1680.9	1653.8	0.0	0.015	6.7	418.3	376.5	0.14	0.2	15467
68	0.0	20.1	1683.0	1654.9	0.0	0.015	6.7	431.3	386.9	0.14	0.2	16916
70	0.0	20.1	1685.2	1656.1	0.0	0.014	6.7	444.8	397.7	0.14	0.2	18453
72	0.0	20.1	1687.4	1657.2	0.0	0.014	6.7	458.7	408.9	0.14	0.2	20081
74	0.0	20.1	1689.6	1658.5	0.0	0.014	6.7	473.1	420.5	0.14	0.2	21801
76	0.0	20.1	1691.8	1659.7	0.0	0.013	6.7	488.0	432.5	0.14	0.2	23617
78	0.0	20.1	1694.1	1661.0	0.0	0.013	6.7	503.3	444.9	0.14	0.2	25531
80	0.0	20.1	1696.3	1662.3	0.0	0.013	6.7	519.1	457.7	0.14	0.2	27546
82	0.0	20.1	1698.6	1663.7	0.0	0.012	6.7	535.4	470.9	0.14	0.2	29664
84	0.0	20.1	1700.9	1665.0	0.0	0.012	6.7	552.2	484.4	0.14	0.2	31887
86	0.0	20.1	1703.2	1666.4	0.0	0.070	6.7	569.4	498.4	0.14	0.2	34220
88	0.0	20.1	1705.6	1667.9	0.0	0.068	6.7	587.1	512.7	0.14	0.2	36663
90	0.0	20.1	1707.9	1669.3	0.0	0.067	6.7	605.3	527.5	0.14	0.2	39220
92	0.0	20.1	1710.3	1670.8	0.0	0.065	6.7	623.9	542.6	0.14	0.2	41893

APPENDIX 2 - Storage Tank Factors by Diameter

TANK DIAMETER (ft)	FLOATING											FIXED ROOF
	External Roof					Internal Roof						
			F_F					F_F		K_D	S_D	
	N_C	K_R	Pontoon	Double	K_D	N_C	K_R	Bolted	Welded	Bolted	Bolded	V_F
94	0.0	20.1	1712.7	1672.4	0.0	0.064	6.7	643.0	558.2	0.14	0.2	44685
96	0.0	20.1	1715.2	1673.9	0.0	0.063	6.7	662.6	574.1	0.14	0.2	47599
98	0.0	20.1	1717.6	1675.5	0.0	0.061	6.7	682.6	590.4	0.14	0.2	50636
100	0.0	20.1	1720.1	1677.1	0.0	0.070	6.7	703.1	607.1	0.14	0.2	53800
102	0.0	20.1	1722.5	1678.8	0.0	0.069	6.7	724.1	624.3	0.14	0.2	57093
104	0.0	20.1	1725.0	1680.4	0.0	0.067	6.7	745.6	641.8	0.14	0.2	60518
106	0.0	20.1	1727.6	1682.2	0.0	0.066	6.7	767.5	659.7	0.14	0.2	64077
108	0.0	20.1	1730.1	1683.9	0.0	0.065	6.7	789.9	677.9	0.14	0.2	67773
110	0.0	20.1	1732.7	1685.7	0.0	0.064	6.7	812.8	696.6	0.14	0.2	71608
112	0.0	20.1	1735.2	1687.5	0.0	0.063	6.7	836.1	715.7	0.14	0.2	75585
114	0.0	20.1	1737.8	1689.3	0.0	0.061	6.7	859.9	735.2	0.14	0.2	79707
116	0.0	20.1	1740.5	1691.2	0.0	0.060	6.7	884.2	755.0	0.14	0.2	83976
118	0.0	20.1	1743.1	1693.1	0.0	0.059	6.7	909.0	775.3	0.14	0.2	88395
120	0.0	20.1	1745.8	1695.0	0.0	0.067	6.7	934.2	796.0	0.14	0.2	92966
122	0.0	20.1	1748.4	1696.9	0.0	0.066	6.7	959.9	817.0	0.14	0.2	97693
124	0.0	20.1	1751.1	1698.9	0.0	0.065	6.7	986.1	838.4	0.14	0.2	102576
126	0.0	20.1	1753.8	1700.9	0.0	0.063	6.7	1012.7	860.3	0.14	0.2	107620
128	0.0	20.1	1756.6	1703.0	0.0	0.063	6.7	1039.8	882.5	0.14	0.2	112827
130	0.0	20.1	1759.3	1705.1	0.0	0.062	6.7	1067.4	905.1	0.14	0.2	118199
132	0.0	20.1	1762.1	1707.2	0.0	0.061	6.7	1095.4	928.1	0.14	0.2	123738
134	0.0	20.1	1764.9	1709.3	0.0	0.060	6.7	1123.9	951.6	0.14	0.2	129448

APPENDIX 2 - Storage Tank Factors by Diameter

TANK DIAMETER (ft)	FLOATING											FIXED ROOF
	External Roof					Internal Roof						
			F_F					F_F		K_D	S_D	
	N_C	K_R	Pontoon	Double	K_D	N_C	K_R	Bolted	Welded	Bolted	Bolded	V_F
136	0.0	20.1	1767.7	1711.5	0.0	0.066	6.7	1152.9	975.4	0.14	0.2	135332
138	0.0	20.1	1770.5	1713.7	0.0	0.065	6.7	1182.4	999.5	0.14	0.2	141390
140	0.0	20.1	1773.4	1715.9	0.0	0.064	6.7	1212.3	1024.1	0.14	0.2	147627
142	0.0	20.1	1776.3	1718.2	0.0	0.063	6.7	1242.7	1049.1	0.14	0.2	154045
144	0.0	20.1	1779.2	1720.4	0.0	0.063	6.7	1273.6	1074.5	0.14	0.2	160646
146	0.0	20.1	1782.1	1722.8	0.0	0.062	6.7	1304.9	1100.3	0.14	0.2	167433
148	0.0	20.1	1785.0	1725.1	0.0	0.061	6.7	1336.7	1126.4	0.14	0.2	174408
150	0.0	20.1	1788.0	1727.5	0.0	0.107	6.7	1369.0	1153.0	0.14	0.2	181575
152	0.0	20.1	1790.9	1729.9	0.0	0.105	6.7	1401.7	1179.9	0.14	0.2	188935
154	0.0	20.1	1793.9	1732.4	0.0	0.104	6.7	1434.9	1207.3	0.14	0.2	196492
156	0.0	20.1	1796.9	1734.8	0.0	0.103	6.7	1468.6	1235.0	0.14	0.2	204247
158	0.0	20.1	1799.9	1737.3	0.0	0.101	6.7	1502.8	1263.1	0.14	0.2	212204
160	0.0	20.1	1803.0	1739.9	0.0	0.100	6.7	1537.4	1291.7	0.14	0.2	220365
162	0.0	20.1	1806.1	1742.4	0.0	0.099	6.7	1572.5	1320.6	0.14	0.2	228732
164	0.0	20.1	1809.1	1745.0	0.0	0.098	6.7	1608.1	1349.9	0.14	0.2	237309
166	0.0	20.1	1812.2	1747.7	0.0	0.096	6.7	1644.1	1379.6	0.14	0.2	246097
168	0.0	20.1	1815.4	1750.3	0.0	0.095	6.7	1680.7	1409.7	0.14	0.2	255100
170	0.0	20.1	1818.5	1753.0	0.0	0.112	6.7	1717.6	1440.2	0.14	0.2	264319
172	0.0	20.1	1821.7	1755.7	0.0	0.110	6.7	1755.1	1471.1	0.14	0.2	273759
174	0.0	20.1	1824.9	1758.5	0.0	0.109	6.7	1793.0	1502.4	0.14	0.2	283420
176	0.0	20.1	1828.1	1761.2	0.0	0.108	6.7	1831.4	1534.0	0.14	0.2	293306

APPENDIX 2 - Storage Tank Factors by Diameter

TANK DIAMETER (ft)	FLOATING											FIXED ROOF
	External Roof					Internal Roof						
			F_F					F_F		K_D	S_D	
	N_C	K_R	Pontoon	Double	K_D	N_C	K_R	Bolted	Welded	Bolted	Bolded	V_F
178	0.0	20.1	1831.3	1764.0	0.0	0.107	6.7	1870.3	1566.1	0.14	0.2	303419
180	0.0	20.1	1834.5	1766.9	0.0	0.106	6.7	1909.6	1598.6	0.14	0.2	313762
182	0.0	20.1	1837.8	1769.8	0.0	0.104	6.7	1949.4	1631.4	0.14	0.2	324337
184	0.0	20.1	1841.1	1772.7	0.0	0.103	6.7	1989.7	1664.7	0.14	0.2	335147
186	0.0	20.1	1844.4	1775.6	0.0	0.102	6.7	2030.4	1698.3	0.14	0.2	346195
188	0.0	20.1	1847.7	1778.6	0.0	0.101	6.7	2071.6	1732.3	0.14	0.2	357483
190	0.0	20.1	1851.0	1781.5	0.0	0.116	6.7	2113.3	1766.8	0.14	0.2	369014
192	0.0	20.1	1854.4	1784.6	0.0	0.115	6.7	2155.5	1801.6	0.14	0.2	380790
194	0.0	20.1	1857.8	1787.6	0.0	0.113	6.7	2198.1	1836.8	0.14	0.2	392814
196	0.0	20.1	1861.2	1790.7	0.0	0.112	6.7	2241.2	1872.4	0.14	0.2	405089
198	0.0	20.1	1864.6	1793.8	0.0	0.111	6.7	2284.8	1908.4	0.14	0.2	417617
200	0.0	20.1	1868.0	1797.0	0.0	0.110	6.7	2328.8	1944.8	0.14	0.2	430400

APPENDIX 3: Default TAC Profile for Select Petroleum Products

Crude Oil			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	0.40	86.17
Benzene	71432	0.60	78.11
Isooctane	26635643	0.10	114.22
Toluene	108883	1.00	92.13
Ethylbenzene	100414	0.40	106.17
Xylene (-m)	1330207	1.40	106.17
Isopropyl benzene	98828	0.10	120.20
1,2,4-Trimethylbenzene	95636	0.33	120.19
Cyclohexane	110827	0.70	84.16

Distillate Fuel Oil #2 (Diesel)			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	0.00	86.17
Benzene	71432	0.00	78.11
Toluene	108883	0.03	92.13
Ethylbenzene	100414	0.01	106.17
Xylene (-m)	1330207	0.29	106.17
1,2,4-Trimethylbenzene	95636	1.00	120.19

Gasoline			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	1.00	86.17
Benzene	71432	1.80	78.11
Isooctane	26635643	4.00	114.22
Toluene	108883	7.00	92.13
Ethylbenzene	100414	1.40	106.17
Xylene (-m)	1330207	7.00	106.17
Isopropyl benzene	98828	0.50	120.20
1,2,4-Trimethylbenzene	95636	2.50	120.19
Cyclohexane	110827	0.24	84.16

Gasoline (Oxygenated with MTBE)			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	1.00	86.17
Benzene	71432	1.80	78.11
Isooctane	26635643	4.00	114.22
Toluene	108883	7.00	92.13
Ethylbenzene	100414	1.40	106.17
Xylene (-m)	1330207	7.00	106.17
Isopropyl benzene	98828	0.50	120.20
1,2,4-Trimethylbenzene	95636	2.50	120.19
Cyclohexane	110827	0.24	84.16
Methyl-tert-butyl ether (MTBE)	1634044	12.00	88.15

Gasoline (Reformulated with MTBE)			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	1.00	86.17
Benzene	71432	1.80	78.11
Isooctane	26635643	4.00	114.22
Toluene	108883	7.00	92.13
Ethylbenzene	100414	1.40	106.17
Xylene (-m)	1330207	7.00	106.17
Isopropyl benzene	98828	0.50	120.20
Methyl-tert-butyl ether (MTBE)	1634044	8.80	88.15
1,2,4-Trimethylbenzene	95636	2.50	120.19
Cyclohexane	110827	0.24	84.16

Jet Kerosene (Jet A)			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	0.01	86.17
Benzene	71432	0.00	78.11
Toluene	108883	0.13	92.13
Ethylbenzene	100414	0.13	106.17
Xylene (-m)	1330207	0.31	106.17

Jet Naphtha (JP-4)			
Chemical Name	**CAS Number**	**Liquid Weight (%)**	**Molecular Weight**
Hexane (-n)	110543	1.50	86.17
Benzene	71432	0.60	78.11
Toluene	108883	2.00	92.13
Ethylbenzene	100414	0.50	106.17
Xylene (-m)	1330207	2.50	106.17
Isopropyl benzene	98828	0.20	120.20
Cyclohexane	110827	1.20	84.16