Tank Calculation Updates & Reporting Practices

A&WMA – Louisiana Section Annual Conference

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CONSULTING SERVICES

Agenda

- Storage Tank Calculation Methodology Overview
  - Storage Tank Emissions by Tank Type
    - Fixed Roof Tank
    - Floating Roof Tank
  - AP-42 Chapter 7 Updates
- Case Study: Pre-AP-42 Update vs. Post-AP-42 Update Sensitivity Analysis
- Storage Tank Emissions Inventory Reporting Practices

Storage Tank Calculation Methodology Overview

- Fixed Roof Tank
  - Routine Losses
    - Standing Losses
      - Emissions associated with vapor expansion and contraction due to temperature and barometric pressure changes.
    - Working Losses
      - Emissions associated with the evaporative loss from filling.
- Floating Roof Tank
  - Routine Losses
    - Standing Losses
      - Emissions associated with the rim seal and deck fitting losses.
    - Working Losses (Withdrawal Loss)
      - Emissions associated with the lowering of the liquid level in the tank.

Storage Tank Calculation Methodology Overview – Fixed Roof Tanks

Total Routine Losses (Eqn. 1-1, AP-42 Chapter 7, 06/20)

- $L_T = L_S + L_W$
  - $L_T = Total\ Routine\ Losses\ \left(\frac{lb}{yr}\right)$
  - $L_S = Total\ Standing\ Losses\ \left(\frac{lb}{yr}\right)$
  - $L_W = Total\ Working\ Losses\ \left(\frac{lb}{yr}\right)$

Standing Losses (Eqn. 1-2, AP-42 Chapter 7, 06/20)

- $L_S = 365 \cdot (\frac{\pi}{4} D^2 \cdot H_{VO}) \cdot W_V \cdot K_E \cdot K_S$
  - $D\ = Tank\ Diameter\ (ft)$
  - $H_{VO} = Vapor\ Space\ Outage\ (ft)$
  - $W_V = Stock\ Vapor\ Density\ \left(\frac{lb}{ft^3}\right)$
  - $K_E = Vapor\ Space\ Expansion\ Factor, per\ day$
  - $K_S = Vented\ Vapor\ Saturation\ Factor, Dimensionless$
  - $365 =$ $Constant, Number\ of\ Daily\ Events\ in\ a\ Year, Days\ per\ Year$

Working Losses (Eqn. 1-35, AP-42 Chapter 7, 06/20)

- $L_W = V_Q \cdot K_N \cdot K_P \cdot W_V \cdot K_B$
  - $V_Q = Net\ Working\ Loss\ Throughput\ \left(\frac{ft^3}{yr}\right)$
  - $K_N =$ $Working\ Loss\ Turnover\ (Saturation)\ Factor, Dimensionless$
    - *Turnovers > 36, K_N = (180+N)/6N; Turnovers ≤ K_N = 1*
  - $K_P = Working\ Loss\ Product\ Factor, Dimensionless$
    - *Crude, K_P = 0.75; All other K_P = 1*
  - $K_B = Vent\ Setting\ Correction\ Factor, Dimensionless$

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Storage Tank Calculation Methodology Overview – Floating Roof Tanks

- **Total Routine Losses** (Eqn. 2-1, AP-42 Chapter 7, 06/20)
  - $L_T = L_S + L_W$
    - $L_T = Total\ Routine\ Losses\ \left(\frac{lb}{yr}\right)$
    - $L_S = Total\ Standing\ Losses\ \left(\frac{lb}{yr}\right)$
    - $L_W = Total\ Working\ (Withdrawal) Losses\ \left(\frac{lb}{yr}\right)$
- **Standing Losses** (Eqn. 2-2, AP-42 Chapter 7, 06/20)
  - $L_S = L_R \cdot L_F \cdot L_D$
    - $L_R = Rim\ Seal\ Losses\ \left(\frac{lb}{yr}\right), See\ Eqn\ 2-3$
    - $L_F = Deck\ Fitting\ Losses\ \left(\frac{lb}{yr}\right), See\ Eqn.\ 2\text{–}13$
    - $L_D =$ $Deck\ Seam\ Losses\ (Internal\ Floating\ Roof\ (IFR) Tanks\ Only)\ \left(\frac{lb}{yr}\right),$ $See\ Eqn.\ 2\text{–}18$
- **Working Losses** (Eqn. 2-19, AP-42 Chapter 7, 06/20)
  - $L_W = \frac{0.943 \cdot Q \cdot C_S \cdot W_L}{D} \cdot \left(1 + \frac{N_C \times F_C}{D}\right)$
    - $Q = Annual\ Net\ Throughput\ \left(\frac{bbl}{yr}\right)$
    - $C_S = Shell\ Clingage\ Factor\ \left(\frac{bbl}{1000\ ft^2}\right)$
    - $W_L = Average\ Organic\ Liquid\ Density\ \left(\frac{lb}{gal}\right)$
    - $D\ = Tank\ Diameter\ (ft)$
    - $0.943\ = Constant, 1{,}000\ ft^3 \cdot \frac{gal}{bbl^2}$
    - $N_C = Number\ of\ Fixed\ Roof\ Support\ Columns, Dimensionless$
      - $Self-Supporting\ Fixed\ Roof\ or\ External\ Floating\ Roof\ (EFR)), N_C = 0$
      - $Column-Supported\ Fixed\ Roof, N_C = Use\ Tank\ Specific\ Info\ or\ Table\ 7.1-11$
    - $F_C = Effective\ Column\ Diameter\ (ft)(Column\ Perimeter\ \frac{[ft]}{\pi})$

Storage Tank AP-42 Calculation Updates

- Removal and Clarification of Alternative Working Loss Equation for Fixed Roof Tanks
- Provided Net Working Loss Throughput Guidance
- Updated Paint Solar Absorptance Data
- Updated Meteorological Data
- Temperature Equation Updates
- Added Methodologies for Calculating Emissions from Non-Routine Activities (i.e., Tank Cleanings)
- New Emission Factors for Additional Guidepole Fittings
- Specified TANKS 4.09d was no longer being updated and supported by the Environmental Protection Agency (EPA)

Storage Tank AP-42 Calculation Updates Continued

- Net Working Loss Throughput Guidance
  - Revision included language to detail that the Net Working Loss Throughput, V_Q is most accurately quantified by the increases in liquid level in the tank as opposed to utilizing pump throughput.
- Updated Paint Solar Absorptance Data
  - Historical Paint Reflective Conditions only included "Good" and "Poor"
  - New Paint Reflective Conditions Updated to include "New", "Average" and "Aged"

Old Factors

Table 7.1-7. PAINT SOLAR ABSORPTANCE FOR FIXED ROOF TANKS[a]

		Paint Factors (α) Paint Condition	
Paint Color	Paint Shade or Type	Good	Poor
Aluminum	Specular	0.39	0.49
Aluminum	Diffuse	0.60	0.68
Gray	Light	0.54	0.63
Gray	Medium	0.68	0.74
Red	Primer	0.89	0.91
White	NA	0.17	0.34

New Factors

Table 7.1-6. PAINT SOLAR ABSORPTANCE[a]

Surface Color	Shade or Type	Reflective Condition (see Note 1)		
		New	Average	Aged
White		0.17	0.25	0.34
Aluminum	Specular	0.39	0.44	0.49
Aluminum	Diffuse	0.60	0.64	0.68
Beige/Cream		0.35	0.42	0.49
Black		0.97	0.97	0.97
Brown		0.58	0.62	0.67
Gray	Light	0.54	0.58	0.63

Storage Tank AP-42 Calculation Updates Continued

- Temperature Equation Updates (Fixed Roof Tanks (Uninsulated))
  - Updated the equations for Average Daily Vapor Temperature Range (ΔT_V) and Daily Average Liquid Surface Temperature (T_{LA}) to be based off a default value of H_S/D = 0.5 for uninsulated fixed roof tanks or calculated.
    - Old Equations:
      - $\Delta T_V = 0.72 \cdot \Delta T_A + 0.028 \cdot \alpha \cdot I$
      - $T_{LA} = 0.44 \cdot T_{AA} + 0.56 \cdot T_B + 0.0079 \cdot \alpha \cdot I$
    - New Equations (H_S/D = 0.5):
      - $\Delta T_V = 0.7 \cdot \Delta T_A + 0.02 \cdot \alpha \cdot I$
      - $T_{LA} = 0.4 \cdot T_{AA} + 0.6 \cdot T_B + 0.005 \cdot \alpha \cdot I$
    - New Equations (H_S/D = Calculated):
      - $\Delta T_V = \left(1 - \left(\frac{0.8}{2.2 \cdot \frac{H_S}{D} + 1.9}\right)\right) \cdot \Delta T_A + \frac{(0.042 \cdot \alpha_R \cdot I) + 0.026 \cdot \frac{H_S}{D} \cdot \alpha_S \cdot I}{2.2 \cdot \frac{H_S}{D} + 1.9}$
      - $T_{LA} = \left(0.5 - \left(\frac{0.8}{4.4 \cdot \frac{H_S}{D} + 3.8}\right)\right) \cdot T_{AA} + \left(0.5 - \left(\frac{0.8}{4.4 \cdot \frac{H_S}{D} + 3.8}\right)\right) \cdot T_B + \frac{(0.0212 \cdot \alpha_R \cdot I) + 0.013 \cdot \frac{H_S}{D} \cdot \alpha_S \cdot I}{4.4 \cdot \frac{H_S}{D} + 3.8}$
  - Included language detailing that it is always preferable to use measured liquid bulk temperature data rather than calculating it from an equilibrium with ambient atmospheric conditions.

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Storage Tank AP-42 Calculation Updates Continued

- Temperature Equation Updates (Floating Roof Tanks (Uninsulated))
  - Updated the equations for Daily Average Liquid Surface Temperature (T_{LA}) to be based off a default value of H_S/D = 0.5 or calculated.
    - New Equations (H_S/D = 0.5):
      - Uninsulated IFR / Domed EFR
        - $T_{LA} = 0.3 \cdot T_{AA} + 0.7 \cdot T_B + 0.004 \cdot \alpha \cdot I$
      - EFR Steel Pontoon Single Deck
        - $T_{LA} = 0.7 \cdot T_{AA} + 0.3 \cdot (T_{AA} + 0.007 \cdot \alpha \cdot I) + 0.008 \cdot \alpha \cdot I$
      - EFR Steel Double Deck
        - $T_{LA} = 0.3 \cdot T_{AA} + 0.7 \cdot (T_{AA} + 0.005 \cdot \alpha \cdot I) + +0.009 \cdot \alpha \cdot I$
    - New Equations (H_S/D = Calculated):
      - Uninsulated IFR / Domed EFR
        - $T_{LA} = \frac{\left(2.86 \cdot \frac{H_S}{D} + 1.43\right) \cdot T_{AA} + \left(3.52 \cdot \frac{H_S}{D} + 3.79\right) \cdot T_B + (0.027 \cdot \alpha_R \cdot I) + (0.017 \cdot \frac{H_S}{D} \cdot \alpha_S \cdot I)}{6.38 \cdot \frac{H_S}{D} + 5.22}$
      - EFR Steel Pontoon Single Deck
        - $T_{LA} = 0.7 \cdot T_{AA} + 0.3 \cdot (T_{AA} + \frac{(0.71 \cdot \alpha_R \cdot I + 0.485 \cdot \frac{H_S}{D} \cdot \alpha_S \cdot I)}{(170 \cdot \frac{H_S}{D} + 57)} + 0.008 \cdot \alpha_R \cdot I$
      - EFR Steel Double Deck
        - $T_{LA} = 0.3 \cdot T_{AA} + 0.7 \cdot (T_{AA} + \frac{(0.39 \cdot \alpha_R \cdot I + 0.485 \cdot \frac{H_S}{D} \cdot \alpha_S \cdot I)}{(170 \cdot \frac{H_S}{D} + 45)} + 0.009 \cdot \alpha \cdot I$
  - Included language detailing that it is always preferable to use measured liquid bulk temperature data rather than calculating it from an equilibrium with ambient atmospheric conditions.

Storage Tank AP-42 Calculation Updates Continued

- Updated Meteorological Data
  - Meteorological Data was updated to include Average Wind Speed (V) and Average Atmospheric Pressure (P_A) in Table 7.1-7 Meteorological Data for Selected U.S. Locations.
- Added Methodologies for Calculating Emissions from Non-Routine Activities (i.e., Tank Cleanings) (Section 7.1.3.4 of AP-42 Chapter 7)
  - Note: This methodology is used to calculate the amount of vapors that are emitted from tanks during activities such as maintenance.
- Added Additional Fitting Emission Factors
  - Rim Seals
    - Added emission factors for “tight-fitting” rim seals along with the definition as follows in Table 7.1-8:

      “Tight-fitting” means that the rim seal is maintained with no gaps greater than 1/8 in. wide between the rim seal and the tank shell. It is not appropriate to use the values for tight-fitting seals unless the seal is known to be maintained with gaps no greater than 1/8 in. through the full range of liquid level in the tank.
  - Deck Fittings
    - Added emission factors for the following fittings in Table 7.1-12:
      - Flexible enclosure as a slotted guidepole control
      - Ladder sleeve as a ladder-guidepole control
    - Specified Deck Legs for IFR and EFR Tanks

Case Study: Pre-AP-42 Update vs. Post-AP-42 Update Sensitivity Analysis

- Tank Characteristics:

Tank Type	Product	RVP	Throughput (BPY)	Diameter (ft)	Height (ft)	Fixed Roof Type	Floating Roof Type	Shell & Roof Condition (Pre-2019)	Shell & Roof Condition (Post-2019)
EFR	Gasoline	13.5	1,000,000	150	40	No Fixed Roof (Open Top)	Steel Pontoon-Type EFR	Good	Average
Horizontal	Diesel	-	1,000	4	6	Horizontal Tank	No Floating Roof (FXR)	Good	Average
IFR	Gasoline	13.5	1,000,000	150	40	Column-Supported (Cone)	Steel Welded Deck IFR	Good	Average
VFRT	Diesel	-	1,000,000	150	40	Column-Supported (Cone)	No Floating Roof (FXR)	Good	Average

- Assumptions:
  - New Orleans, Louisiana Meteorological Data
  - Shell & Roof Finish = White

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Case Study: Pre-AP-42 Update vs. Post-AP-42 Update Sensitivity Analysis

- Temperature Equation & Meteorological Data Updates

Element	ΔT_V			T_{LA}		
	FXR	IFR	EFR	FXR	IFR	EFR
Met. Constants	2%	N/A	N/A	4%	4%	4%
Equation Update	-11%	N/A	N/A	-1%	-1%	1%
Total	**-10%**	N/A	N/A	**3%**	**3%**	**5%**

- Utilized Default H_S/D = 0.5 Equations
  - Fixed Roof Tanks
    - $\Delta T_V = 0.7 \cdot \Delta T_A + 0.02 \cdot \alpha \cdot I$
    - $T_{LA} = 0.4 \cdot \ T_{AA} + 0.6 \cdot T_B + 0.005 \cdot \alpha \cdot I$
  - IFR
    - $T_{LA} = 0.3 \cdot \ T_{AA} + 0.7 \cdot T_B + 0.004 \cdot \alpha \cdot I$
  - EFR Steel Pontoon Single Deck
    - $T_{LA} = 0.7 \cdot \ T_{AA} + 0.3 \cdot (T_{AA} + 0.007 \cdot \alpha \cdot I) + \ 0.008 \cdot \alpha \cdot I$

Case Study: Pre-AP-42 Update vs. Post-AP-42 Update Sensitivity Analysis

- Emissions Summary

Tank Type	Standing Losses (lbs)		Percent Change	Working Losses (lbs)		Percent Change	Total Emissions (lbs)		Percent Change
	Pre-2019	Post-2019		Pre-2019	Post-2019		Pre-2019	Post-2019	
EFR	21,284.48	22,758.45	6.93%	52.81	52.81	0.00%	21,337.28	22,811.26	6.91%
Horizontal	0.10	0.10	-6.22%	0.64	0.67	5.91%	0.74	0.77	4.22%
IFR	44,862.48	47,400.94	5.66%	87.31	87.31	0.00%	44,949.79	47,488.25	5.65%
VFRT	990.82	928.62	-6.28%	1,148.70	1,216.62	5.91%	2,139.51	2,145.24	0.27%

Case Study: Pre-AP-42 Update vs. Post-AP-42 Update Sensitivity Analysis

- Tight-Fitting Rim Seal Option

Tank Type	Rim Seal Type	Standing Losses (lbs)	Rim Seal Loss (lbs)	Percent Change
EFR	Mechanical-Shoe Primary with Rim-Mounted Secondary	22758.45	9066	-5%
EFR	Tight-fitting Mechanical-Shoe Primary with Rim-Mounted Secondary	22279.03	8586	

- All Tank Characteristics, Product, Throughput, and Fittings were the same. Only the Rim Seal Type was changed.

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Storage Tank Emissions Inventory Reporting Practices

- Louisiana Department of Environmental Quality (LDEQ) required facilities to utilize the updated AP-42, Chapter 7.1 methodology beginning in Reporting Year 2020 (RY2020) for Emissions Inventory (EI).

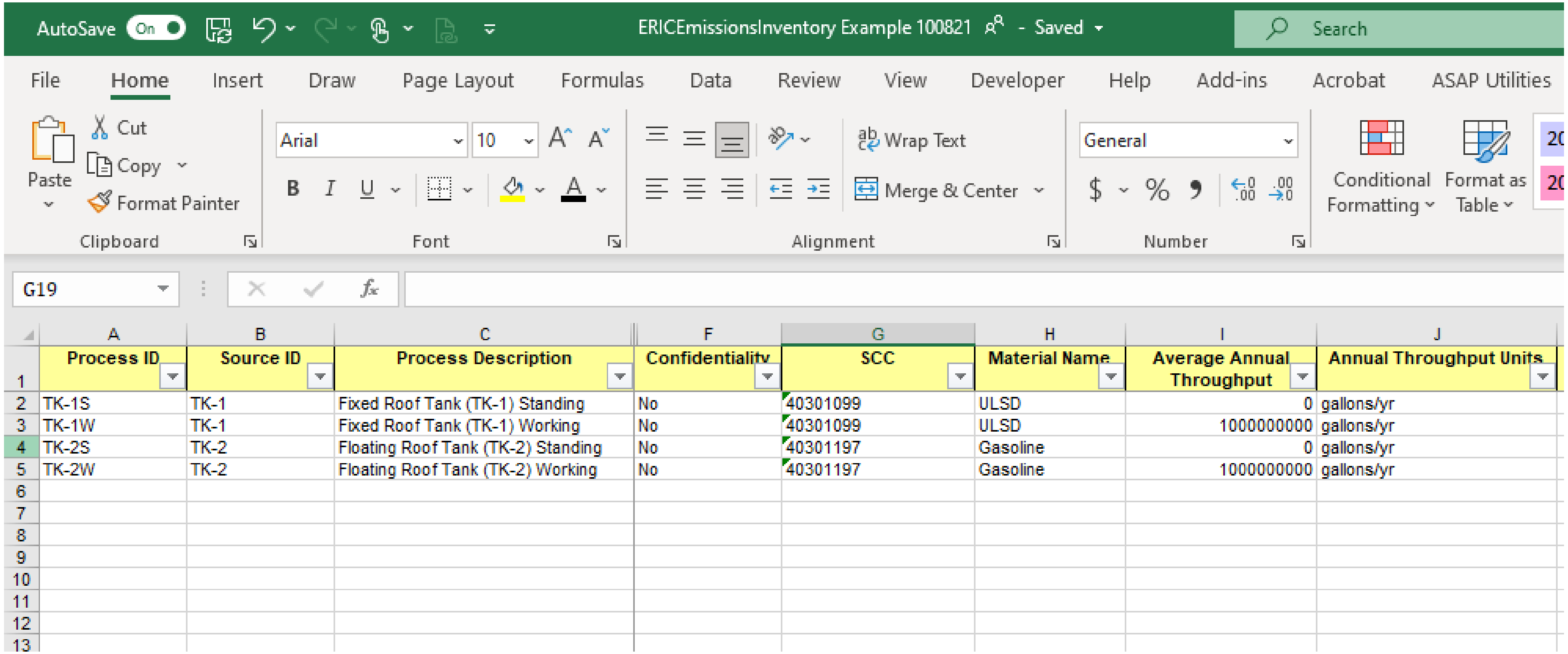
- Additionally, LDEQ requires facilities to report emissions as they are calculated.
  - Working Loss Emissions
  - Standing (Breathing) Loss Emissions

- So how do we report storage tanks in the Emissions Reporting and Inventory Center (ERIC) for EI?

ERIC Upload Example – Sources Tab

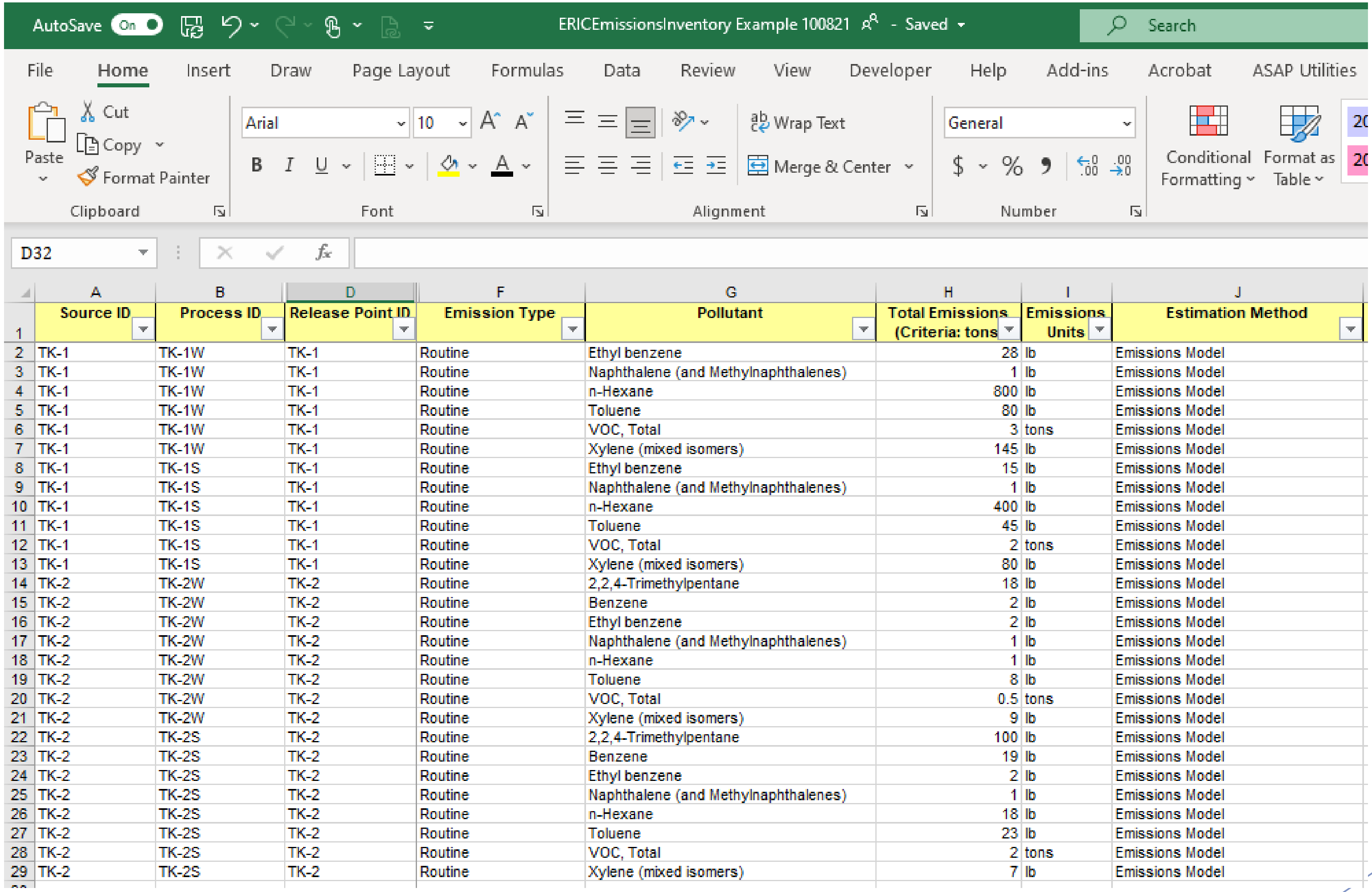
Source ID	Subject Item ID	Source Description	Source Type	Permit Number	EIQ Number	Status	SIC
TK-1	EQT00000000001	ULSD Tank	Above ground storage vessel	0000-V0	TK-1	Active	2911
TK-2	EQT00000000002	Gasoline Tank	Above ground storage vessel	0000-V0	TK-2	Active	2911

ERIC Upload Example – Processes Tab



Process ID	Source ID	Process Description	Confidentiality	SCC	Material Name	Average Annual Throughput	Annual Throughput Units
TK-1S	TK-1	Fixed Roof Tank (TK-1) Standing	No	40301099	ULSD	0	gallons/yr
TK-1W	TK-1	Fixed Roof Tank (TK-1) Working	No	40301099	ULSD	1000000000	gallons/yr
TK-2S	TK-2	Floating Roof Tank (TK-2) Standing	No	40301197	Gasoline	0	gallons/yr
TK-2W	TK-2	Floating Roof Tank (TK-2) Working	No	40301197	Gasoline	1000000000	gallons/yr

ERIC Upload Example – Emissions Tab



	Source ID	Process ID	Release Point ID	Emission Type	Pollutant	Total Emissions (Criteria: tons	Emissions Units	Estimation Method
2	TK-1	TK-1W	TK-1	Routine	Ethyl benzene	28	lb	Emissions Model
3	TK-1	TK-1W	TK-1	Routine	Naphthalene (and Methylnaphthalenes)	1	lb	Emissions Model
4	TK-1	TK-1W	TK-1	Routine	n-Hexane	800	lb	Emissions Model
5	TK-1	TK-1W	TK-1	Routine	Toluene	80	lb	Emissions Model
6	TK-1	TK-1W	TK-1	Routine	VOC, Total	3	tons	Emissions Model
7	TK-1	TK-1W	TK-1	Routine	Xylene (mixed isomers)	145	lb	Emissions Model
8	TK-1	TK-1S	TK-1	Routine	Ethyl benzene	15	lb	Emissions Model
9	TK-1	TK-1S	TK-1	Routine	Naphthalene (and Methylnaphthalenes)	1	lb	Emissions Model
10	TK-1	TK-1S	TK-1	Routine	n-Hexane	400	lb	Emissions Model
11	TK-1	TK-1S	TK-1	Routine	Toluene	45	lb	Emissions Model
12	TK-1	TK-1S	TK-1	Routine	VOC, Total	2	tons	Emissions Model
13	TK-1	TK-1S	TK-1	Routine	Xylene (mixed isomers)	80	lb	Emissions Model
14	TK-2	TK-2W	TK-2	Routine	2,2,4-Trimethylpentane	18	lb	Emissions Model
15	TK-2	TK-2W	TK-2	Routine	Benzene	2	lb	Emissions Model
16	TK-2	TK-2W	TK-2	Routine	Ethyl benzene	2	lb	Emissions Model
17	TK-2	TK-2W	TK-2	Routine	Naphthalene (and Methylnaphthalenes)	1	lb	Emissions Model
18	TK-2	TK-2W	TK-2	Routine	n-Hexane	1	lb	Emissions Model
19	TK-2	TK-2W	TK-2	Routine	Toluene	8	lb	Emissions Model
20	TK-2	TK-2W	TK-2	Routine	VOC, Total	0.5	tons	Emissions Model
21	TK-2	TK-2W	TK-2	Routine	Xylene (mixed isomers)	9	lb	Emissions Model
22	TK-2	TK-2S	TK-2	Routine	2,2,4-Trimethylpentane	100	lb	Emissions Model
23	TK-2	TK-2S	TK-2	Routine	Benzene	19	lb	Emissions Model
24	TK-2	TK-2S	TK-2	Routine	Ethyl benzene	2	lb	Emissions Model
25	TK-2	TK-2S	TK-2	Routine	Naphthalene (and Methylnaphthalenes)	1	lb	Emissions Model
26	TK-2	TK-2S	TK-2	Routine	n-Hexane	18	lb	Emissions Model
27	TK-2	TK-2S	TK-2	Routine	Toluene	23	lb	Emissions Model
28	TK-2	TK-2S	TK-2	Routine	VOC, Total	2	tons	Emissions Model
29	TK-2	TK-2S	TK-2	Routine	Xylene (mixed isomers)	7	lb	Emissions Model

Question and Answer

Eric Rucinski
Eric.Rucinski@emsi-air.com
225-400-3861

Matthew Arseneaux
Matt.Arseneaux@valero.com
985-764-5596