Appendix I

AIR QUALITY WORKSHEETS

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CLIENT Sunoco Pipeline L.P. (SPLP)		JOB NUMBER 112IC05958.20	
SUBJECT Block Valve Calculations for an Emergency Fire Restricting Device (EFRD) Fugitive Emission Estimate			
BASED ON SPLP Process and Instrumentation Drawings (P&IDs)		DRAWING NUMBER	
BY VJPlachy	CHECKED BY AMO'Bradovich		DATE 9/14/2016

Objective: Calculation the Maximum Hourly, Maximum Daily, and Annual Average Emissions associated with fugitive components for the proposed fittings, valves, relief valves, and other miscellaneous component types for each type of valve station.

Inputs and Assumptions:

1. Component counts

Equipment Counts:		**Other Components:**	
Fittings:	43	Coriolis Meter	0
Valves:	12	Prover	0
Relief Valves:	0	Composite Sampler	0
Pump Seals:	0	Instruments	4
		Static Mixer	0
		Check Valves	0
		TOTAL Other Components	4

2. The leak emission factors are taken from the USEPA Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017, November, 1995, Table 2-3 for light liquid service.
3. Emission Leak Factors:

Fittings:	8.00E-06	kilogram per hour per component (kg/hr-component)
Valves:	4.30E-05	kg/hr-component
Relief Valves:	1.30E-04	kg/hr-component
Pump Seals:	5.40E-04	kg/hr-component
Other Components:	1.30E-04	kg/hr-component

4. Assume the total organic compound emissions are equivalent to total VOCs.
5. The HAP content as a result of the LPG ($WT\%_{HAP}$): 5.86 wt %
6. The relief valves on any butane, propane, and ethane spheres/tanks that release to the atmosphere are fugitive emitters.
7. Butane, propane, and ethane do not contain any HAPs.
8. Number of atmospheric relief valves on non-HAP spheres/tanks (N_{RVBPS}): 0 Relief Valves
9. The contingency (Cont) for as-built modifications during the construction phase is: 20 %
10. Operating service factor (OSF): 100 %

Calculations:

1. Convert the component leak EFs from kg/hr-component to lb/hr-component ($EF_{lb/hr\text{-}component}$).

Using fittings as an example:

$$EF_{Fittings\_b/hr\text{-}component} = (EF_{kg/hr\text{-}component}) * (CF_{kg\text{-}g}) / (CF_{g\text{-}lb})$$

$$= \frac{8.00E\text{-}06 \ \cancel{kg}}{hr\text{-}component} \left| \frac{1{,}000 \ \cancel{g}}{1 \ \cancel{kg}} \right| \frac{1 \ lb}{453.6 \ \cancel{g}} = 1.76E\text{-}05 \ lb/hr\text{-}component$$

Equipment Type	Leak EF (lb/hr-component)
Fittings	1.76E-05
Valves	9.48E-05
Relief Valves to atm	2.87E-04
Pump Seals	1.19E-03
Other Components	2.87E-04

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Calculations (Continued):

2. Calculate the VOC Max Hourly ER in lb/hr ($ER_{VOClb/hr}$).
   Using fittings as an example:

$ER_{Fittings\text{-}VOClb/hr} = (EF_{lb/hr\text{-}component}) * (EC_{Fittings})$

$= \frac{1.76E\text{-}05 \text{ lb}}{\text{hr-}\sout{\text{component}}} \quad 43 \quad \sout{\text{components}} = 7.58E\text{-}04 \text{ lb VOCs/hr}$

Equipment Type	Leak EF (lb/hr-component)	Equipment Count	VOC Max Hourly (lb/hr)
Fittings	1.76E-05	43	7.58E-04
Valves	9.48E-05	12	1.14E-03
Relief Valves to atm	2.87E-04	0	N/C
Pump Seals	1.19E-03	0	N/C
Other Components	2.87E-04	4	1.15E-03
		TOTAL:	**3.04E-03**

3. Calculate the ER for HAPs in lb/hr ($ER_{RV\text{-}HAPlb/hr}$) for the relief valves to atmosphere (not butane or propane sphere relief valves).

$ER_{RV\text{-}HAPlb/hr} = \{ (EF_{RV\text{-}lb/hr\text{-}component}) * [(EC_{RV}) - (N_{RVBPS})] \} * [(WT\%_{HAP}) / (CF_{\%\text{-}DecEq})]$

$= \frac{2.87E\text{-}04 \text{ lb}}{\text{hr-}\sout{\text{component}}} \quad 0 - 0 \ \sout{\text{comp}} * 5.86 \ \sout{\text{wt\%}} \ \frac{1 \ \sout{\text{DecEq}}}{100 \ \sout{\text{wt\%}}} = 0.00E+00 \text{ lb HAPs/hr}$

4. Calculate the ER for HAPs in lb/hr ($ER_{HAPlb/hr}$) for the fittings, valves, and other components.
   Using fittings as an example:

$ER_{Fittings\text{-}HAPlb/hr} = (ER_{Fittings\text{-}VOClb/hr}) * (WT\%_{HAP}) / (CF_{\%\text{-}DecEq})$

$= \frac{7.58E\text{-}04 \text{ lb}}{\text{hr}} \quad 5.86 \ \sout{\%} \ \frac{1 \ \sout{\text{DecEq}}}{100 \ \sout{\text{wt\%}}} = 4.44E\text{-}05 \text{ lb HAPs/hr}$

Equipment Type	HAP Max Hourly (lb/hr)
Fittings	4.44E-05
Valves	6.67E-05
Relief Valves to atm	N/C
Pump Seals	N/C
Other Components	6.72E-05
TOTAL:	**1.78E-04**

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Calculations (Continued):

5. Calculate the Max Daily ER for VOCs and HAPs in lb/day ($ER_{VOC\text{-}lb/day}$)
   Using fittings VOCs as an example:

$ER_{FittingsVOC\text{-}lb/day} = (ER_{Fittings\text{-}VOClb/hr}) * (CF_{hr\text{-}day})$

$$= \frac{7.58E\text{-}04 \text{ lb}}{\text{hr}} \left| \frac{24 \text{ hr}}{\text{day}} \right. = 1.82E\text{-}02 \text{ lb/hr}$$

Equipment Type	Max Daily (lb/day)	
	VOC	HAP
Fittings	1.82E-02	1.07E-03
Valves	2.73E-02	1.60E-03
Relief Valve to atm	N/C	N/C
Pump Seals	N/C	N/C
Other Components	2.75E-02	1.61E-03
TOTAL	**7.30E-02**	**4.28E-03**

6. Calculate the Annual ER for VOCs in tpy ($ER_{VOC\text{-}tpy}$).

   Using fittings as an example:

$ER_{FittingsVOC\text{-}tpy} = (ER_{FittingsVOC\text{-}lb/hr}) * (CF_{hr\text{-}yr}) * (OSF) / (CF_{\%\text{-}DecEq}) / (CF_{lb\text{-}tons})$

$$= \frac{7.58E\text{-}04 \text{ lb}}{\text{hr}} \left| \frac{8{,}760 \text{ hr}}{\text{yr}} \right. \left. 100 \text{ \%} \right| \frac{1 \text{ DecEq}}{100 \text{ \%}} \left| \frac{1 \text{ t}}{2{,}000 \text{ lb}} \right. = 3.32E\text{-}03 \text{ tpy VOCs}$$

Equipment Type	VOC Max Hourly (lb/hr)	VOC Annual Average (tpy)
Fittings	7.58E-04	3.32E-03
Valves	1.14E-03	4.98E-03
Relief Valves to atm	N/C	N/C
Pump Seals	N/C	N/C
Other Components	1.15E-03	5.02E-03
TOTAL		**1.33E-02**

7. Calculate the ER for HAPs in tpy ($ER_{RV\text{-}HAPtpy}$) for the relief valve to atmosphere (this is in addition to the butane or propane sphere relief valves).

$ER_{RV\text{-}HAPtpy} = (ER_{RV\text{-}HAPlb/hr}) * (CF_{hr\text{-}yr}) * (OSF) / (CF_{\%\text{-}DecEq}) / (CF_{lb\text{-}ton})$

$$= \frac{0.00E+00 \text{ lb}}{\text{hr}} \left| \frac{8{,}760 \text{ hr}}{\text{yr}} \right. \left. 100 \text{ \%} \right| \frac{1 \text{ DecEq}}{100 \text{ \%}} \left| \frac{1 \text{ t}}{2{,}000 \text{ lb}} \right. = 0.00E+00 \text{ tpy HAPs}$$

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Calculations (Continued):

8. Calculate the ER for HAPs in tpy (ER_{HAPtpy}) for fittings, valves, and other components.
   Using fittings as an example:

$ER_{Fittings\text{-}HAPtpy} = (ER_{Fittings\text{-}VOCtpy}) * (WT\%_{HAP}) / (CF_{\%\text{-}DecEq})$

$$= \frac{3.32E\text{-}03 \text{ ton}}{\text{year}} \left| \frac{5.86 \text{ wt\%}}{} \right| \frac{1 \text{ DecEq}}{100 \text{ \%}} = 1.95E\text{-}04 \text{ tpy HAPs}$$

Equipment Type	HAP Annual (tpy)
Fittings	1.95E-04
Valves	2.92E-04
Relief Valves to atm	N/C
Pump Seals	N/C
Other Components	2.94E-04
TOTAL:	**7.81E-04**

9. Incorporate the contingency into Maximum Hourly and Annual Average VOC fugitives ($TF_{VOCMax\text{-}Ann}$).
   Using Maximum Hourly as an example:

$TF_{VOCMaxHrly\text{-}lb/hr} = (ER_{TOTAL\text{-}VOClb/hr}) * [(1) + (Cont\%) / (CF_{\%\text{-}Dec\ Eq})]$

$$= \frac{3.04E\text{-}03 \text{ lb}}{\text{hr}} \left| 1 + \right| \frac{20 \text{ \%}}{} \left| \frac{1 \text{ DecEq}}{100 \text{ \%}} \right| = 3.65E\text{-}03 \text{ lb VOCs/hr}$$

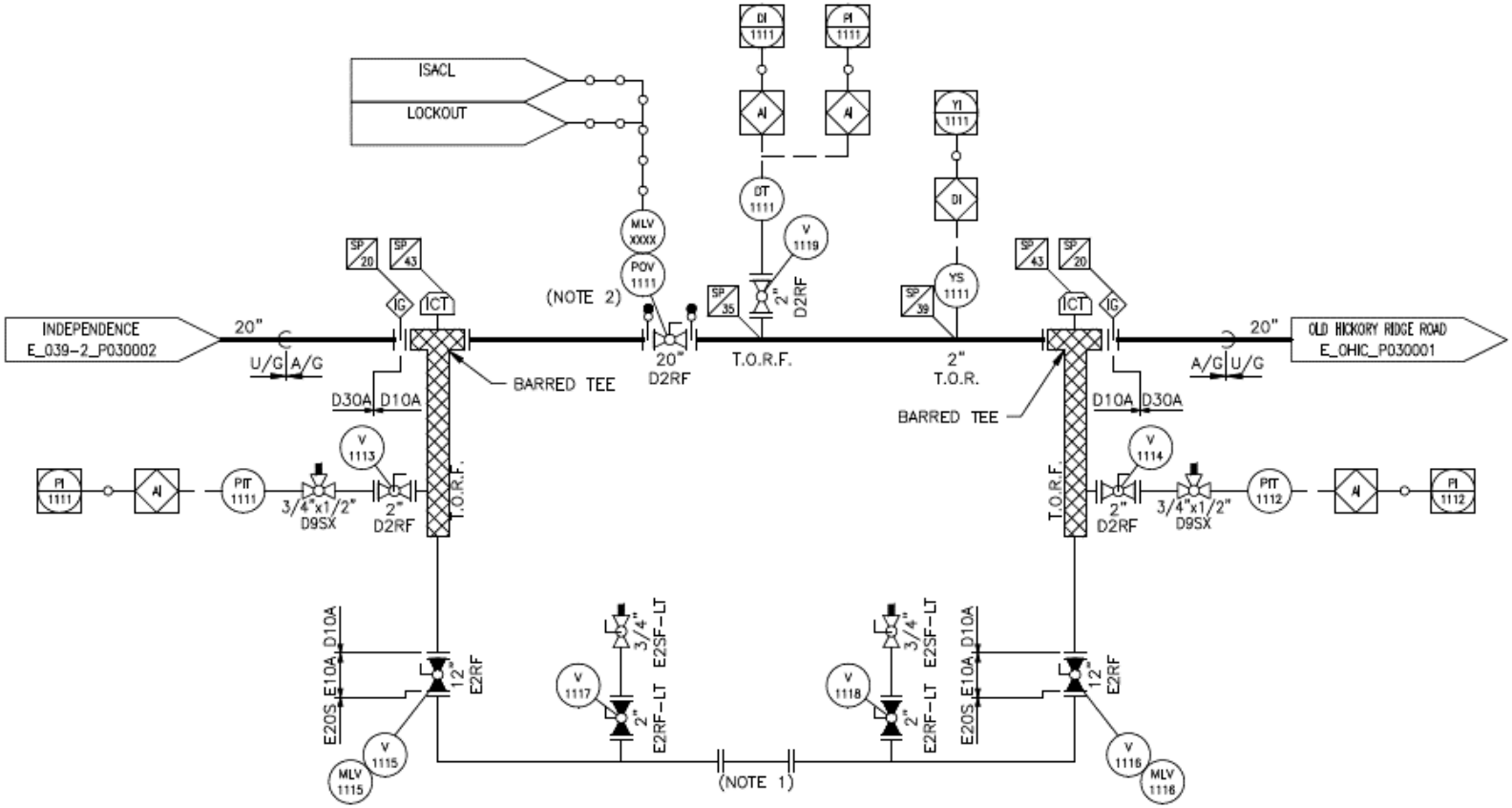
VOC Fugitive Emission Rate		
Type	**ER**	**TF_{VOC}**
Max Hourly (lb/hr)	0.003	0.004
Max Daily (lb/day)	0.07	0.09
Annual Average (tpy)	0.01	0.02

10. Incorporate the contingency into Maximum Hourly and Annual Average total HAP fugitives ($TF_{HAPMaxHrly}$).
    Using Maximum Hourly as an example:

$TF_{HAPMaxHrly\text{-}lb/hr} = (ER_{TOTAL\text{-}HAPlb/hr}) * [(1) + (Cont\%) / (CF_{\%\text{-}Dec\ Eq})]$

$$= \frac{1.78E\text{-}04 \text{ lb}}{\text{hr}} \left| 1 + \right| \frac{20 \text{ \%}}{} \left| \frac{1 \text{ DecEq}}{100 \text{ \%}} \right| = 2.14E\text{-}04 \text{ lb HAPs/hr}$$

HAP Fugitive Emission Rate		
Type	**ER**	**TF_{HAP}**
Max Hourly (lb/hr)	0.0002	0.0002
Max Daily (lb/day)	0.004	0.01
Annual Average (tpy)	0.001	0.001


ISACL
LOCKOUT
DI 1111
PI 1111
AI
AI
YI 1111
DI
DT 1111
V 1119
2" D2RF
MLV XXXX
POV 1111
(NOTE 2)
SP 20
SP 43
SP 35
SP 39
YS 1111
IG
ICT
INDEPENDENCE
E_039-2_P030002
20"
U/G A/G
D30A D10A
BARRED TEE
20" D2RF
T.O.R.F.
2" T.O.R.
BARRED TEE
D10A D30A
A/G U/G
20"
OLD HICKORY RIDGE ROAD
E_OHIC_P030001
PI 1111
AI
PIT 1111
3/4"x1/2" D9SX
V 1113
2" D2RF
T.O.R.F.
T.O.R.F.
V 1114
2" D2RF
3/4"x1/2" D9SX
PIT 1112
AI
PI 1112
E20S_E10A_D10A
12" E2RF
V 1115
MLV 1115
V 1117
3/4" 2" E2SF-LT E2RF-LT
V 1118
3/4" 2" E2SF-LT E2RF-LT
E20S_E10A_D10A
12" E2RF
V 1116
MLV 1116
(NOTE 1)