

Battery Application (14-8)100.14-17-3-29

APPENDIX B- Gas Dispersion Information

Assumptions used in Modeling

Input 3 different scenarios:

Oil Volume (m³/d): (1) 6.2, (2) 6.2, (3) 30

Water Volume (m³/d): (1) 25, (2) 25, (3) 25

FORMATION GOR (m³/m³): (1) 26, (2) 50, (3) 100

Assumption of total gas volume (m³/d)= (1) 161.2, (2) 620, (3) 1500

H₂S volume: used gas analysis from 102.4-11-3-29 (Aug 23, 2022).

3-23-12-27 0.0139 mole Fraction 20.00 g/m³ hydrogen sulfide

Scenario 1: Oil 6.2 m3/day, GOR 26 m3/m3						
Branch Screen3 Calculator						
Company	Tundra			Date Reviewed	30-Aug-22	
Facility	14-8-3-29			Name	J.Abey, L. Flannery	
Assumption:	100 % of the gas through the flare in a SWB.					
RED are inputs						
Oil (m3)	6.2			Treater	Flare	Tank Vent
H2O (m3)	25	% volume of total		0	100	0
GOR (m3/m3)	26	m3		0	161.2	0
Total Gas=	161.2 m3					
Mole Fraction	0.0139		Date of test	Taken from 102/4-11-3-29 dated Aug 23, 2022		
	Treater	Flare		Tank Vent		
Vent Height (m)	4.5	Vent Height (m)	12.2	Vent Height (m)	10	
Stack ID (m)	0.4573	Stack ID (m)	0.0762	Stack ID (m)	0.0762	
	point		point		point	Source
RESULTS						
Flare						
Vent stack Exit Flow Rate	2.59338E-05 m3/s					
Emission Rate	H2S	0.037381233 g/s				
	SO2	0.070266843 g/s				
Vent stack area	0.004560233 m2					
Vent stack exit velocity	0.409132783 m/s					



Sour Gas Flare Properties

Company **Tundra Oil & Gas**
 Facility **414-8-3-29**
 Case **SWB- SO2**

Flow Rate

Gas Stream	flare	scrubber	total gas	
Flow Rate	0.161	0.000	0.161	10 ³ m ³ /d at 15°C and 101.3 kPa
Percentage	100.0	0.0	100.0	%
Reference Temp	15	15	15	°C

Composition (dry)

				Mole Fraction
H ₂	0.0002		0.0002	
He	0.0003		0.0003	
N ₂	0.1204		0.1204	
CO ₂	0.0156		0.0156	
H ₂ S	0.0139		0.0139	
C ₁	0.4164		0.4164	
C ₂	0.2064		0.2064	
C ₃	0.1583		0.1583	
<i>i</i> C ₄	0.0167		0.0167	
<i>n</i> C ₄	0.0359		0.0359	
<i>i</i> C ₅	0.0051		0.0051	
<i>n</i> C ₅	0.0049		0.0049	
C ₆	0.0024		0.0024	
C ₇₊	0.0035		0.0035	
Total	1.0000	0.0000	1.0000	

Gas Stream Properties

Molecular Mass	28.74	0.00	28.74	kg/kmole
Net Heating Value	48.94	0.00	48.94	10 ³ m ³ /d at 15°C and 101.3 kPa
Net Heat Release Rate	21,811	0	21,811	cal/s
Equivalent SO ₂ Inlet	0.006	0.000	0.006	t/d
Equivalent SO ₂ Inlet	0.07	0.00	0.07	g/s

Stack Parameters

Flare Stack Height	12.2	m		
Flare Stack Diameter	76.00	mm		
Actual Exit Velocity	0.41	m/s		
Length of Flame:	0.69	m		
Heat Intensity at Base	1.05	kW/m ²	Background = 1.04 kW/m ²	
Conversion Efficiency	100.00	%		
Radiation Loss	25	%	(Brode => 55%, AENV => 25%)	
Sensible Heat Release	16,358	cal/s	Based on conversion efficiency & radiation loss	

Model Input Parameters

Effective Stack Height	12.74	m	(per EPA and Beychok, M.; 1979)
Pseudo-diameter	0.881	m	based on actual exit velocity
Actual Exit Velocity	0.41	m/s	
Exit Temperature	1273	K	1000 °C
Ambient temperature	288	K	Pseudo temperature for modelling

Emissions

SO ₂ Emission	0.070	g/s	Based on user-specified conversion efficiency
H ₂ S Emission	0.000	g/s	Based on user-specified conversion efficiency
NO _x Emission	0.003	g/s	Based on US EPA AP-42

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Scenario 1: Oil 6.2 m3/day, GOR 26 m3/m3

08/30/22

09:35:34

*** SCREEN3 MODEL RUN ***

*** VERSION DATED 13043 ***

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = FLARE
 EMISSION RATE (G/S) = 0.700000E-01
 FLARE STACK HEIGHT (M) = 12.2000
 TOT HEAT RLS (CAL/S) = 21811.0
 RECEPTOR HEIGHT (M) = 0.0000
 URBAN/RURAL OPTION = RURAL
 EFF RELEASE HEIGHT (M) = 12.7406
 BUILDING HEIGHT (M) = 0.0000
 MIN HORIZ BLDG DIM (M) = 0.0000
 MAX HORIZ BLDG DIM (M) = 0.0000

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
 THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

BUOY. FLUX = 0.362 M**4/S**3; MOM. FLUX = 0.221 M**4/S**2.

*** FULL METEOROLOGY ***

*** SCREEN AUTOMATED DISTANCES ***

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	U10M STAB	USTK (M/S)	MIX HT (M/S)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH	
1.	0.000	1	1.0	1.0	320.0	22.56	0.62	0.50	NO
100.	16.21	1	1.0	1.0	320.0	22.56	27.00	14.23	NO
200.	18.56	3	1.0	1.0	320.0	22.49	23.78	14.30	NO
300.	16.89	3	1.0	1.0	320.0	22.49	34.40	20.52	NO
400.	16.55	4	1.0	1.0	320.0	22.38	29.58	15.52	NO
500.	15.42	4	1.0	1.0	320.0	22.38	36.25	18.50	NO
600.	13.58	4	1.0	1.0	320.0	22.38	42.81	21.39	NO
700.	11.75	4	1.0	1.0	320.0	22.38	49.27	24.19	NO
800.	10.15	4	1.0	1.0	320.0	22.38	55.64	26.92	NO

900.	8.807	4	1.0	1.0	320.0	22.38	61.94	29.59	NO
1000.	7.686	4	1.0	1.0	320.0	22.38	68.18	32.21	NO
1100.	6.817	4	1.0	1.0	320.0	22.38	74.36	34.24	NO
1200.	6.093	4	1.0	1.0	320.0	22.38	80.49	36.20	NO
1300.	5.955	6	1.0	1.1	10000.0	29.55	43.31	17.16	NO
1400.	6.034	6	1.0	1.1	10000.0	29.55	46.30	17.92	NO
1500.	6.054	6	1.0	1.1	10000.0	29.55	49.27	18.66	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

224.	18.96	3	1.0	1.0	320.0	22.49	26.47	15.87	NO
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DWASH= MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 *** SUMMARY OF SCREEN MODEL RESULTS ***

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	18.96	224.	0.

 ** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **

Scenario 2: Oil 6.2 m3/day, GOR 100 m3/m3

Branch Screen3 Calculator

Company	Tundra	Date Reviewed	30-Aug-22
Facility	14-8-3-29	Name	J.Abey, L. Flannery

Assumption: 100 % of the gas through the flare in a SWB.

RED are inputs

Oil (m3)	6.2		Treater	Flare	Tank Vent	
H2O (m3)	25	% volume of total	0	100	0	100
GOR (m3/m3)	100	m3	0	620	0	620
Total Gas=	620 m3					

Mole Fraction **0.0139** Date of test Taken from 102/4-11-3-29 dated Aug 23, 2022

	Treater	Flare	Tank Vent	
Vent Height (m)	4.5	12.2	10	
Stack ID (m)	0.4573	0.0762	0.0762	
	point	point	point	Source

RESULTS

Flare	
Vent stack Exit Flow Rate	9.97454E-05 m3/s
Emission Rate	H2S 0.143773974 g/s
	SO2 0.270257089 g/s
Vent stack area	0.004560233 m2
Vent stack exit velocity	1.573587625 m/s



Sour Gas Flare Properties

Company Tundra Oil & Gas
Facility 414-8-3-29
Case SWB- SO2. GOR 100 m3m3, Oil 6.2m3/day

Flow Rate

Gas Stream	flare	scrubber	total gas	
Flow Rate	0.620	0.000	0.620	10 ³ m ³ /d at 15°C and 101.3 kPa
Percentage	100.0	0.0	100.0	%
Reference Temp	15	15	15	°C

Composition (dry)

				Mole Fraction
H ₂	0.0002		0.0002	
He	0.0003		0.0003	
N ₂	0.1204		0.1204	
CO ₂	0.0156		0.0156	
H ₂ S	0.0139		0.0139	
C ₁	0.4164		0.4164	
C ₂	0.2064		0.2064	
C ₃	0.1583		0.1583	
iC ₄	0.0167		0.0167	
nC ₄	0.0359		0.0359	
iC ₅	0.0051		0.0051	
nC ₅	0.0049		0.0049	
C ₆	0.0024		0.0024	
C ₇₊	0.0035		0.0035	
Total	1.0000	0.0000	1.0000	

Gas Stream Properties

Molecular Mass	28.74	0.00	28.74	kg/kmole
Net Heating Value	48.94	0.00	48.94	10 ³ m ³ /d at 15°C and 101.3 kPa
Net Heat Release Rate	83,887	0	83,887	cal/s
Equivalent SO ₂ Inlet	0.023	0.000	0.023	t/d
Equivalent SO ₂ Inlet	0.27	0.00	0.27	g/s

Stack Parameters

Flare Stack Height	12.2	m		
Flare Stack Diameter	76.00	mm		
Actual Exit Velocity	1.58	m/s		
Length of Flame:	1.30	m		
Heat Intensity at Base	1.08	kW/m ²		Background = 1.04 kW/m ²
Conversion Efficiency	100.00	%		
Radiation Loss	25	%		(Brode => 55%, AENV => 25%)
Sensible Heat Release	62,916	cal/s		Based on conversion efficiency & radiation loss

Model Input Parameters

Effective Stack Height	13.23	m		(per EPA and Beychok, M.; 1979)
Pseudo-diameter	0.881	m		based on actual exit velocity
Actual Exit Velocity	1.58	m/s		
Exit Temperature	1273	K	1000	°C
Ambient temperature	288	K		Pseudo temperature for modelling

Emissions

SO ₂ Emission	0.270	g/s		Based on user-specified conversion efficiency
H ₂ S Emission	0.000	g/s		Based on user-specified conversion efficiency
NO _x Emission	0.010	g/s		Based on US EPA AP-42

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Scenario 2: Oil 6.2 m3/day, GOR 100 m3/m3

08/30/22

09:50:04

*** SCREEN3 MODEL RUN ***

*** VERSION DATED 13043 ***

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = FLARE
 EMISSION RATE (G/S) = 0.654000
 FLARE STACK HEIGHT (M) = 12.2000
 TOT HEAT RLS (CAL/S) = 202953.
 RECEPTOR HEIGHT (M) = 0.0000
 URBAN/RURAL OPTION = RURAL
 EFF RELEASE HEIGHT (M) = 13.7700
 BUILDING HEIGHT (M) = 0.0000
 MIN HORIZ BLDG DIM (M) = 0.0000
 MAX HORIZ BLDG DIM (M) = 0.0000

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
 THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

BUOY. FLUX = 3.365 M**4/S**3; MOM. FLUX = 2.052 M**4/S**2.

*** FULL METEOROLOGY ***

*** SCREEN AUTOMATED DISTANCES ***

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	U10M STAB	USTK (M/S)	MIX (M/S)	HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
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1.	0.000	1	1.0	1.0	320.0	65.82	1.06	0.99	NO
100.	18.23	1	3.0	3.1	960.0	31.12	27.28	14.75	NO
200.	29.59	2	3.5	3.6	1120.0	28.64	36.42	20.67	NO
300.	31.30	3	3.5	3.6	1120.0	28.50	34.55	20.76	NO
400.	29.53	3	2.5	2.6	800.0	34.39	45.04	27.09	NO
500.	27.05	3	2.0	2.1	640.0	39.55	55.26	33.26	NO
600.	26.16	4	3.0	3.1	960.0	30.68	42.99	21.75	NO
700.	25.09	4	2.5	2.6	800.0	34.06	49.53	24.72	NO
800.	23.94	4	2.5	2.6	800.0	34.06	55.87	27.40	NO
900.	22.84	4	2.0	2.1	640.0	39.14	62.31	30.34	NO

1000.	21.69	4	2.0	2.1	640.0	39.14	68.51	32.90	NO
1100.	20.30	4	2.0	2.1	640.0	39.14	74.66	34.89	NO
1200.	19.41	4	1.5	1.6	480.0	47.59	81.02	37.36	NO
1300.	18.55	4	1.5	1.6	480.0	47.59	87.06	39.21	NO
1400.	17.68	4	1.5	1.6	480.0	47.59	93.06	41.01	NO
1500.	16.82	4	1.5	1.6	480.0	47.59	99.02	42.78	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:
 287. 31.39 3 3.5 3.6 1120.0 28.50 33.30 20.03 NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 *** SUMMARY OF SCREEN MODEL RESULTS ***

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	31.39	287.	0.

 ** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **

Scenario 3: Oil 30 m3/day, GOR 50 m3/m3
Branch Screen3 Calculator

Company Tundra **Date Reviewed** 30-Aug-22
Facility 14-8-3-29 **Name** J.Abey, L. Flannery

Assumption: 100 % of the gas through the flare in a SWB.

RED are inputs

Oil (m3)	30		Treater	Flare	Tank Vent	
H2O (m3)	25	% volume of total		0	100	0
GOR (m3/m3)	50	m3		0	1500	0
Total Gas=	1500 m3					

Mole Fraction **0.0139** Date of test Taken from 102/4-11-3-29 dated Aug 23, 2022

	Treater	Flare	Tank Vent	
Vent Height (m)	4.5	12.2	10	
Stack ID (m)	0.4573	0.0762	0.0762	
	point	point	point	Source

RESULTS

Flare	
Vent stack Exit Flow Rate	0.000241319 m3/s
Emission Rate	H2S 0.34784026 g/s
	SO2 0.653847795 g/s
Vent stack area	0.004560233 m2
Vent stack exit velocity	3.807066835 m/s



Sour Gas Flare Properties

Company **Tundra Oil & Gas**
 Facility **14-8-3-29**
 Case **SWB- SO2. GOR 50m3m3, Oil 30 m3/day**

Flow Rate

Gas Stream	flare	scrubber	total gas	
Flow Rate	1.500	0.000	1.500	10 ³ m ³ /d at 15°C and 101.3 kPa
Percentage	100.0	0.0	100.0	%
Reference Temp	15	15	15	°C

Composition (dry)

				Mole Fraction
H ₂	0.0002		0.0002	
He	0.0003		0.0003	
N ₂	0.1204		0.1204	
CO ₂	0.0156		0.0156	
H ₂ S	0.0139		0.0139	
C ₁	0.4164		0.4164	
C ₂	0.2064		0.2064	
C ₃	0.1583		0.1583	
iC ₄	0.0167		0.0167	
nC ₄	0.0359		0.0359	
iC ₅	0.0051		0.0051	
nC ₅	0.0049		0.0049	
C ₆	0.0024		0.0024	
C ₇₊	0.0035		0.0035	
Total	1.0000	0.0000	1.0000	

Gas Stream Properties

Molecular Mass	28.74	0.00	28.74	kg/kmole
Net Heating Value	48.94	0.00	48.94	10 ³ m ³ /d at 15°C and 101.3 kPa
Net Heat Release Rate	202,953	0	202,953	cal/s
Equivalent SO ₂ Inlet	0.056	0.000	0.056	t/d
Equivalent SO ₂ Inlet	0.65	0.00	0.65	g/s

Stack Parameters

Flare Stack Height	12.2	m		
Flare Stack Diameter	76.00	mm		
Actual Exit Velocity	3.83	m/s		
Length of Flame:	1.98	m		
Heat Intensity at Base	1.13	kW/m ²		Background = 1.04 kW/m ²
Conversion Efficiency	100.00	%		
Radiation Loss	25	%		(Brode => 55%, AENV => 25%)
Sensible Heat Release	152,215	cal/s		Based on conversion efficiency & radiation loss

Model Input Parameters

Effective Stack Height	13.77	m		(per EPA and Beychok, M.; 1979)
Pseudo-diameter	0.881	m		based on actual exit velocity
Actual Exit Velocity	3.83	m/s		
Exit Temperature	1273	K	1000	°C
Ambient temperature	288	K		Pseudo temperature for modelling

Emissions

SO ₂ Emission	0.654	g/s		Based on user-specified conversion efficiency
H ₂ S Emission	0.000	g/s		Based on user-specified conversion efficiency
NO _x Emission	0.025	g/s		Based on US EPA AP-42

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Scenario 3: Oil 30 m3/day, GOR 50 m3/m3

08/30/22

09:45:22

*** SCREEN3 MODEL RUN ***

*** VERSION DATED 13043 ***

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = FLARE
 EMISSION RATE (G/S) = 0.270000
 FLARE STACK HEIGHT (M) = 12.2000
 TOT HEAT RLS (CAL/S) = 83887.0
 RECEPTOR HEIGHT (M) = 0.0000
 URBAN/RURAL OPTION = RURAL
 EFF RELEASE HEIGHT (M) = 13.2292
 BUILDING HEIGHT (M) = 0.0000
 MIN HORIZ BLDG DIM (M) = 0.0000
 MAX HORIZ BLDG DIM (M) = 0.0000

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
 THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

BUOY. FLUX = 1.391 M**4/S**3; MOM. FLUX = 0.848 M**4/S**2.

*** FULL METEOROLOGY ***

 *** SCREEN AUTOMATED DISTANCES ***

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	U10M STAB	USTK (M/S)	MIX (M/S)	HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
1.	0.000	1	1.0	1.0	320.0	40.14	0.84	0.75	NO
100.	21.57	1	3.0	3.1	960.0	22.20	26.98	14.18	NO
200.	24.67	3	3.0	3.1	960.0	22.12	23.76	14.26	NO
300.	25.66	3	2.0	2.1	640.0	26.57	34.50	20.68	NO
400.	23.72	3	1.5	1.5	480.0	31.02	44.94	26.93	NO
500.	22.38	4	2.0	2.1	640.0	26.39	36.34	18.68	NO
600.	21.63	4	1.5	1.6	480.0	30.77	43.01	21.80	NO
700.	20.64	4	1.5	1.6	480.0	30.77	49.44	24.55	NO
800.	19.24	4	1.0	1.0	320.0	39.54	56.08	27.82	NO
900.	18.67	4	1.0	1.0	320.0	39.54	62.34	30.41	NO

1000.	17.76	4	1.0	1.0	320.0	39.54	68.54	32.96	NO
1100.	16.65	4	1.0	1.0	320.0	39.54	74.69	34.94	NO
1200.	15.57	4	1.0	1.0	320.0	39.54	80.79	36.87	NO
1300.	14.55	4	1.0	1.0	320.0	39.54	86.84	38.74	NO
1400.	13.60	4	1.0	1.0	320.0	39.54	92.86	40.56	NO
1500.	12.73	4	1.0	1.0	320.0	39.54	98.83	42.34	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:
 267. 26.18 3 2.0 2.1 640.0 26.57 31.15 18.73 NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 *** SUMMARY OF SCREEN MODEL RESULTS ***

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	26.18	267.	0.

 ** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
