



## Summary SO2 Dispersion Modelling

Client **Surge Energy**  
 Project **Waskada Oil Battery**  
 LSD **LSD 16-03-002-26W1M**

Date **10-Dec-10**  
 By **NA/LMR**  
 Aurora No **10706**

SCENARIO	SCENARIO 1	SCENARIO 2
Description	<b>Emergency Flaring Sulphur in Inlet Gas*</b>	<b>Continuous Flaring Sulphur in Gas to Flare*</b>
Maximum Gas to be Flared	5.66 10 <sup>3</sup> m <sup>3</sup> /d	2.83 10 <sup>3</sup> m <sup>3</sup> /d
	0.20 MMSCFD	0.10 MMSCFD
Maximum H <sub>2</sub> S content in gas	0.25 %m H <sub>2</sub> S	0.25 %m H <sub>2</sub> S
Sulphur Inlet	0.02 t/d Sulphur	0.01 t/d Sulphur
SO <sub>2</sub> Emission	0.04 t/d SO <sub>2</sub>	0.02 t/d SO <sub>2</sub>
Maximum one hour average SO <sub>2</sub> Concentration	<b>3.787 µg/m<sup>3</sup></b>	<b>4.058 µg/m<sup>3</sup></b>
Does it meet the Manitoba limit of 900 µg/m <sup>3</sup> ?	<b>YES</b>	<b>YES</b>

\* Based on rates and H<sub>2</sub>S concentration to be licensed



# EXTENDED GAS ANALYSIS

V0011092 - 4 52134-2010-3383  
 CONTAINER IDENTITY METER ID WELL LICENSE NUMBER LABORATORY FILE NUMBER  
 Surge Energy Inc. 2  
 OPERATOR PAGE  
 100/12-03-002-26W 1/00 Surge Waskada 12-3-2-26  
 LOCATION (UWI) WELL NAME KB ELEV (m) GR ELEV (m)  
 Waskada Core Lab - Estevan  
 FIELD OR AREA POOL OR ZONE SAMPLER

TEST TYPE AND NO. TEST RECOVERY  
 Wellhead Casing  
 POINT OF SAMPLE SAMPLE POINT ID  
 PUMPING FLOWING GAS LIFT SWAB  
 WATER m³/d OIL m³/d GAS m³/d  
 TEST INTERVAL or PERFS (meters)  
 SEPARATOR RESERVOIR OTHER 36 @ 13 °C 30 @ 22 °C SEPARATOR OTHER  
 CONTAINER WHEN SAMPLED CONTAINER WHEN RECEIVED Temperatures, °C  
 11:45 Hrs Pressures, kPa (gauge) TUN @ °C  
 2010 09 21 2010 09 23 2010 09 27 ANALYST AMT. AND TYPE CUSHION MUD RESISTIVITY  
 DATE SAMPLED (Y/M/D) DATE RECEIVED (Y/M/D) DATE ANALYZED (Y/M/D) ANALYST AMT. AND TYPE CUSHION MUD RESISTIVITY

COMPONENT	MOLE FRACTION AIR FREE AS RECEIVED	MOLE FRACTION AIR FREE ACID GAS FREE	ml/m³ AIR FREE AS RECEIVED
H <sub>2</sub>	0.0004	0.0004	
He	0.0001	0.0001	
N <sub>2</sub>	0.0373	0.0380	
CO <sub>2</sub>	0.0153	0.0000	
H <sub>2</sub> S	0.0022	0.0000	
C <sub>1</sub>	0.3074	0.3128	
C <sub>2</sub>	0.1872	0.1905	665.3
C <sub>3</sub>	0.2516	0.2561	924.6
iC <sub>4</sub>	0.0416	0.0423	181.6
C <sub>4</sub>	0.0991	0.1009	416.9
iC <sub>5</sub>	0.0194	0.0198	94.7
C <sub>5</sub>	0.0191	0.0195	92.4
C <sub>6</sub>	0.0076	0.0077	39.6
C <sub>7+</sub>	0.0117	0.0119	61.5
Total	1.0000	1.0000	2,476.6

CALCULATED GROSS HEATING VALUE MJ/m³ @ 15°C & 101.325 kPa (abs.)		CALCULATED VAPOR PRESSURE kPa (abs.) @ 40 °C	
74.68	75.96	96.6	
MOISTURE FREE		PENTANES PLUS	
CALCULATED TOTAL SAMPLE PROPERTIES (AIR=1) @ 15°C & 101.325 kPa MOISTURE FREE AS SAMPLED			
1.531	kg/m³	1.250	36.2
DENSITY		RELATIVE MOLECULAR MASS	
CALCULATED PSEUDOCRITICAL PROPERTIES AS SAMPLED			
4379.3	kPa (abs)	306.7	K
ACID GAS FREE		ACID GAS FREE	
4322.2	kPa (abs)	306.6	K
pPc		pTc	
C <sub>7+</sub> PROPERTIES @ 15°C & 101.325 kPa		MOLE FRACTION LOCATION METHOD	
818.1	kg/m³	99.9	0.0021500 Field Gastec
DENSITY		MOLECULAR WEIGHT	
HYDROGEN SULPHIDE			

*used 0.0025 as per Application*  
*adjusted to 0.3071 to make up for 0.0025 H<sub>2</sub>S*

**REMARKS:**  
 H<sub>2</sub>S determined in the field by Gastec = 2150 ppm  
 Client field conditions were not available.

NOTE: THE GROSS HEATING VALUE HAS BEEN CALCULATED IN ACCORDANCE TO AGA REPORT #5 AND ALL PROPERTIES HAVE BEEN CALCULATED UTILIZING PHYSICAL CONSTANTS AND BOILING POINT GROUPING.

Scenario 1  
(0.2 mmSCFD)

**INPUT VALUES FOR DISPERSION MODELING PROGRAMS**

Total Gas Flow Rate at Reference Temperature (m <sup>3</sup> /s):	0.07
Actual Stack Diameter (m)	0.1016
Stack Height (m):	12.2
Heat Radiation Loss (%)	25
Conversion Efficiency for SO <sub>2</sub> (%)	98
Reference Temperature (K):	288
Standard Temperature (K):	293

Gas Component	Gas Fraction	Gas Flow Rate m <sup>3</sup> /s	Low Heat Value at 15.6C and 101.3kPa MJ/m <sup>3</sup>	Heat Release MJ/s
H2	0.0004	2.7984E-05	10.223	0.00028608
He	0.0001	0.0000		
N2	0.0373	0.0026		
CO2	0.0153	0.0011		
H2S	0.0025	0.0002	21.905	0.00383
CH4	0.3071	0.0215	33.949	0.72939
C2H6	0.1872	0.0131	60.429	0.79141
C3H8	0.2516	0.0176	86.418	1.52113
i-C4H10	0.0416	0.0029	112.007	0.32598
n-C4H10	0.0991	0.0069	112.396	0.77925
i-C5H12	0.0194	0.0014	138.087	0.18742
n-C5H12	0.0191	0.0013	138.380	0.18491
C6H14	0.0076	0.0005	164.399	0.08741
C7H16+	0.0117	0.0008	190.389	0.15584
<b>Total</b>	<b>1.0000</b>	<b>Total Heat Release Rate (MJ/s)</b>		<b>4.76687</b>

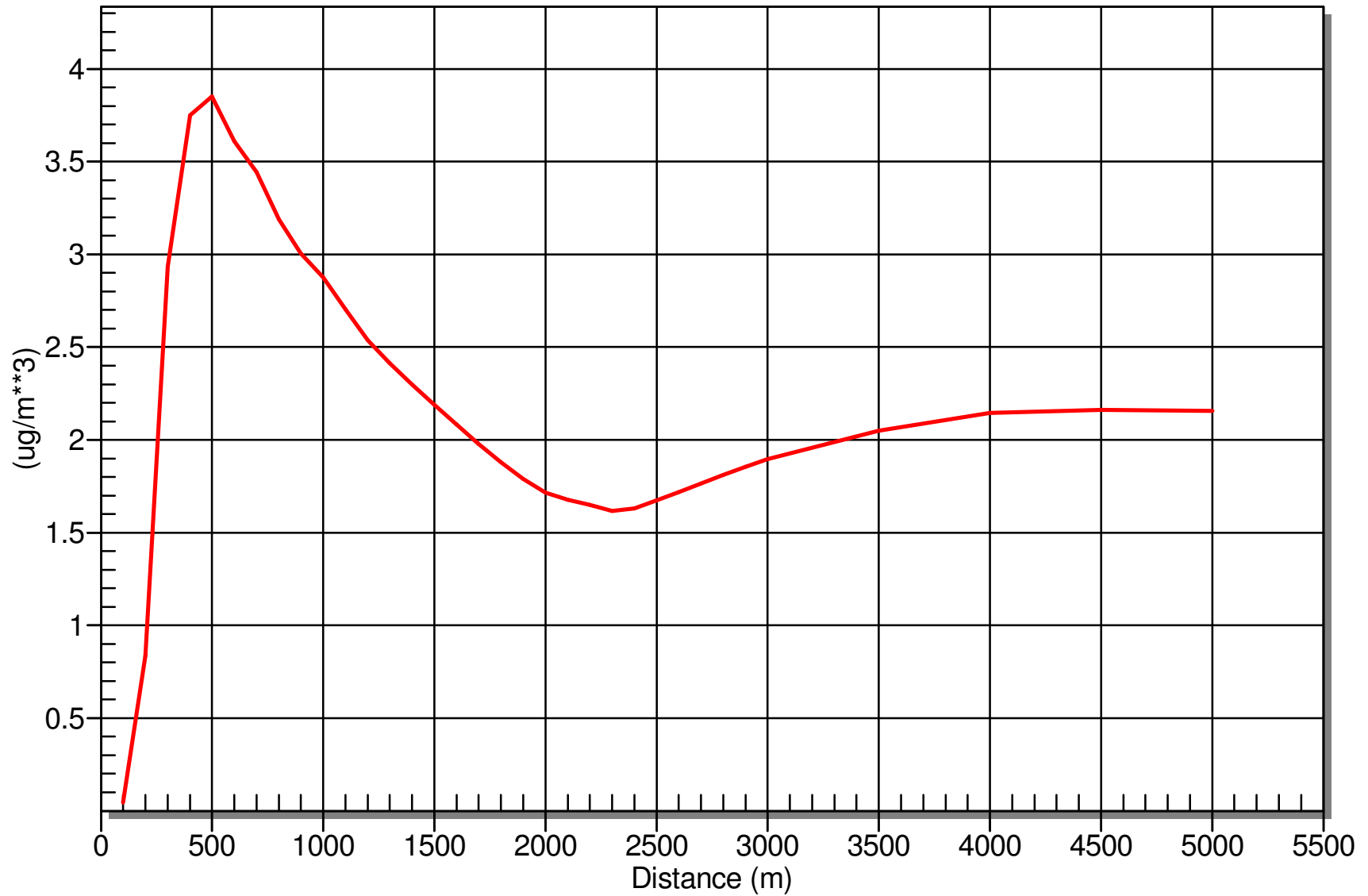
Total Heating Value (MJ/m<sup>3</sup>) **68.1365315**  
 Total Heat Release Rate (cal/s) **1140398.33**  
 Buoyancy Flux (m<sup>4</sup>/s<sup>3</sup>) **31.6460536**

**ADDITIONAL NUMBERS FOR INPUT INTO ISC3 MODEL OR SCREEN 3 AS POINT SOURCE OPTION**

Equivalent Stack temperature (K):	1273
Equivalent Exit Velocity (m/s):	8.5
Effective Stack Height (m)	15.8
Equivalent Stack Diameter (m):	1.402
Emission Rate of SO <sub>2</sub> (g/s):	0.464

# Automated Distance Vs. Concentration

Terrain Height = 0.00 m.



12/10/10

10:31:39

\*\*\* SCREEN3 MODEL RUN \*\*\*  
\*\*\* VERSION DATED 96043 \*\*\*

C:\Documents and Settings\nahmad\My Documents\Ribstone.scr

SIMPLE TERRAIN INPUTS:

SOURCE TYPE	=	POINT
EMISSION RATE (G/S)	=	0.464000
STACK HEIGHT (M)	=	15.8000
STK INSIDE DIAM (M)	=	1.4020
STK EXIT VELOCITY (M/S)	=	8.5000
STK GAS EXIT TEMP (K)	=	1273.0000
AMBIENT AIR TEMP (K)	=	293.0000
RECEPTOR HEIGHT (M)	=	0.0000
URBAN/RURAL OPTION	=	RURAL
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 = 31.532 M\*\*4/S\*\*3; MOM. FLUX = 8.172 M\*\*4/S\*\*  
2.

\*\*\* FULL METEOROLOGY \*\*\*

\*\*\*\*\*  
\*\*\* SCREEN AUTOMATED DISTANCES \*\*\*  
\*\*\*\*\*

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

DIST	CONC		U10M	USTK	MIX HT	PLUME	SIGMA
SIGMA	(UG/M**3)	STAB	(M/S)	(M/S)	(M)	HT (M)	Y (M)
(M)	DWASH						
Z (M)							
1.	0.000	1	1.0	1.0	320.0	291.91	1.46
1.41	NO						
100.	0.4512E-01	5	1.0	1.2	10000.0	104.82	26.16
25.68	NO						
200.	0.8368	3	10.0	10.5	3200.0	41.11	24.09
14.80	NO						
300.	2.933	3	10.0	10.5	3200.0	41.11	34.84
21.25	NO						

400.	3.750	4	20.0	21.4	6400.0	26.02	29.68
15.70	NO						
500.	3.852	4	20.0	21.4	6400.0	26.02	36.35
18.69	NO						
600.	3.609	4	15.0	16.1	4800.0	30.82	43.02
21.81	NO						
700.	3.444	4	15.0	16.1	4800.0	30.82	49.45
24.56	NO						
800.	3.189	4	15.0	16.1	4800.0	30.82	55.80
27.26	NO						
900.	3.006	4	10.0	10.7	3200.0	40.44	62.35
30.43	NO						
1000.	2.876	4	10.0	10.7	3200.0	40.44	68.55
32.98	NO						
1100.	2.705	4	10.0	10.7	3200.0	40.44	74.70
34.96	NO						
1200.	2.537	4	10.0	10.7	3200.0	40.44	80.80
36.88	NO						
1300.	2.413	4	8.0	8.6	2560.0	47.65	87.04
39.17	NO						
1400.	2.300	4	8.0	8.6	2560.0	47.65	93.04
40.98	NO						
1500.	2.188	4	8.0	8.6	2560.0	47.65	99.00
42.74	NO						
1600.	2.081	4	8.0	8.6	2560.0	47.65	104.92
44.47	NO						
1700.	1.978	4	8.0	8.6	2560.0	47.65	110.82
46.16	NO						
1800.	1.881	4	8.0	8.6	2560.0	47.65	116.67
47.82	NO						
1900.	1.789	4	8.0	8.6	2560.0	47.65	122.50
49.44	NO						
2000.	1.715	4	5.0	5.4	1600.0	69.04	128.84
52.41	NO						
2100.	1.677	2	1.0	1.0	320.0	291.91	308.69
258.98	NO						
2200.	1.649	2	1.0	1.0	320.0	291.91	320.86
271.31	NO						
2300.	1.616	2	1.0	1.0	320.0	291.91	332.99
283.75	NO						
2400.	1.631	5	1.5	1.8	10000.0	93.57	115.06
43.30	NO						
2500.	1.675	5	1.5	1.8	10000.0	93.57	119.23
44.06	NO						
2600.	1.717	5	1.0	1.2	10000.0	104.82	124.01
46.48	NO						
2700.	1.766	5	1.0	1.2	10000.0	104.82	128.14
47.19	NO						
2800.	1.812	5	1.0	1.2	10000.0	104.82	132.25
47.90	NO						
2900.	1.855	5	1.0	1.2	10000.0	104.82	136.36
48.60	NO						
3000.	1.895	5	1.0	1.2	10000.0	104.82	140.46
49.29	NO						

3500.	2.050	5	1.0	1.2	10000.0	104.82	160.78
52.66	NO						
4000.	2.145	5	1.0	1.2	10000.0	104.82	180.86
55.89	NO						
4500.	2.163	5	1.0	1.2	10000.0	104.82	200.70
58.62	NO						
5000.	2.155	5	1.0	1.2	10000.0	104.82	220.33
61.24	NO						

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:  
 465. 3.878 4 20.0 21.4 6400.0 26.02 34.10  
 17.70 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

\*\*\* INVERSION BREAK-UP FUMIGATION CALC. \*\*\*  
 CONC (UG/M\*\*3) = 4.291  
 DIST TO MAX (M) = 3725.57

\*\*\*\*\*  
 \*\*\* SUMMARY OF SCREEN MODEL RESULTS \*\*\*  
 \*\*\*\*\*

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
-----	-----	-----	-----
SIMPLE TERRAIN	3.878	465.	0.
INV BREAKUP FUMI	4.291	3726.	--

\*\*\*\*\*  
 \*\* REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS \*\*  
 \*\*\*\*\*

**INPUT VALUES FOR DISPERSION MODELING PROGRAMS (0.1 mmSCFD)**

Total Gas Flow Rate at Reference Temperature (m³/s):	0.03
Actual Stack Diameter (m)	0.1016
Stack Height (m):	12.2
Heat Radiation Loss (%)	25
Conversion Efficiency for SO <sub>2</sub> (%)	98
Reference Temperature (K):	288
Standard Temperature (K):	293

Gas Component	Gas Fraction	Gas Flow Rate m³/s	Low Heat Value at 15.6C and 101.3kPa MJ/m³	Heat Release MJ/s
H2	0.0004	1.3992E-05	10.223	0.00014304
He	0.0001	0.0000		
N2	0.0373	0.0013		
CO2	0.0153	0.0005		
H2S	0.0025	0.0001	21.905	0.00192
CH4	0.3071	0.0107	33.949	0.36469
C2H6	0.1872	0.0065	60.429	0.39571
C3H8	0.2516	0.0088	86.418	0.76057
i-C4H10	0.0416	0.0015	112.007	0.16299
n-C4H10	0.0991	0.0035	112.396	0.38963
i-C5H12	0.0194	0.0007	138.087	0.09371
n-C5H12	0.0191	0.0007	138.380	0.09245
C6H14	0.0076	0.0003	164.399	0.04371
C7H16+	0.0117	0.0004	190.389	0.07792
<b>Total</b>	<b>1.0000</b>	<b>Total Heat Release Rate (MJ/s)</b>		<b>2.38343</b>

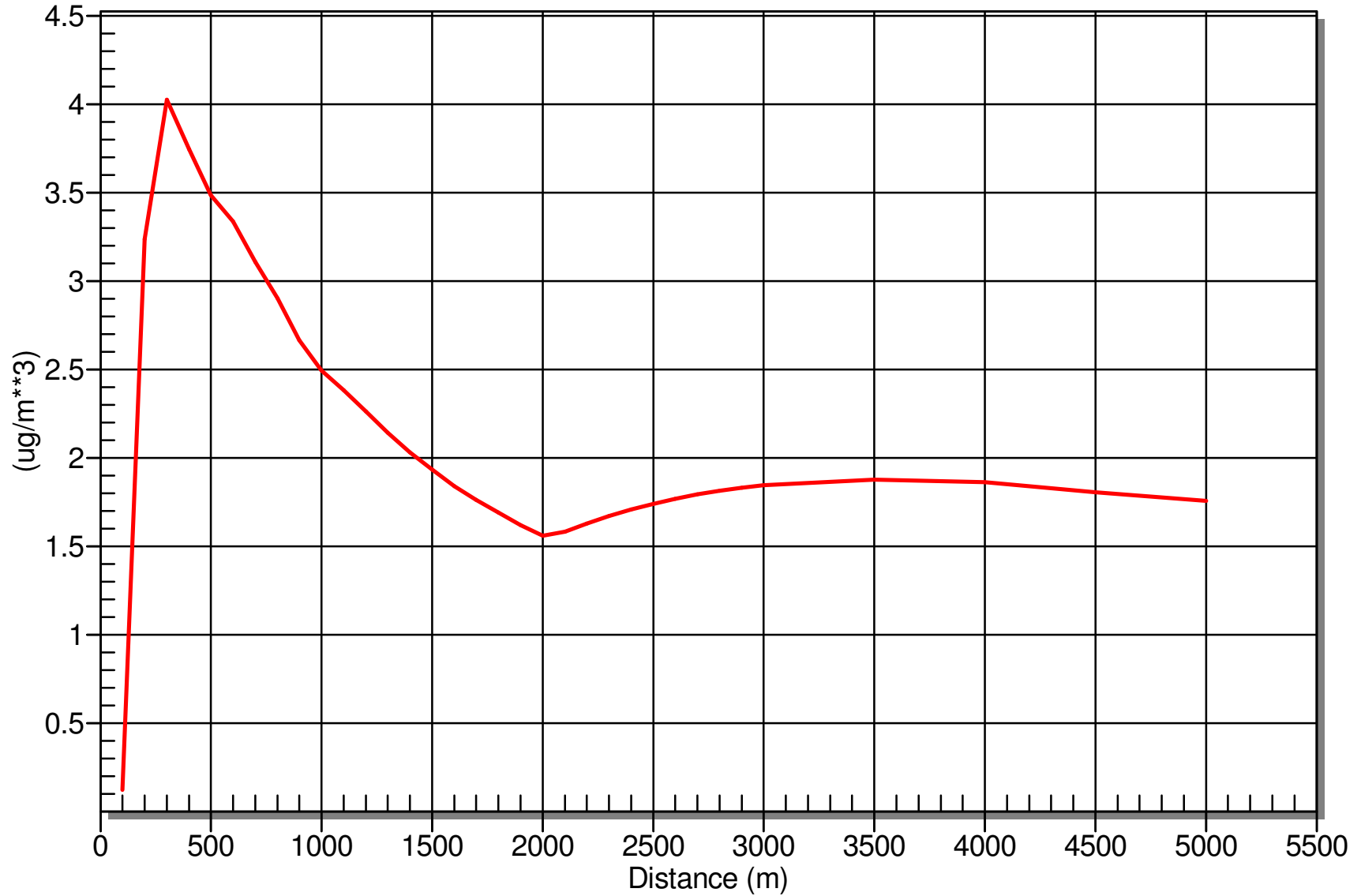
Total Heating Value (MJ/m³)	<b>68.1365315</b>
Total Heat Release Rate (cal/s)	<b>570199.163</b>
Buoyancy Flux (m⁴/s³)	<b>15.8230268</b>

**ADDITIONAL NUMBERS FOR INPUT INTO ISC3 MODEL OR SCREEN 3 AS POINT SOURCE OPTION**

Equivalent Stack temperature (K):	<b>1273</b>
Equivalent Exit Velocity (m/s):	<b>4.2</b>
Effective Stack Height (m)	<b>14.8</b>
Equivalent Stack Diameter (m):	<b>1.402</b>
Emission Rate of SO <sub>2</sub> (g/s):	<b>0.232</b>

# Automated Distance Vs. Concentration

Terrain Height = 0.00 m.



12/10/10

10:34:17

\*\*\* SCREEN3 MODEL RUN \*\*\*  
\*\*\* VERSION DATED 96043 \*\*\*

C:\Documents and Settings\nahmad\My Documents\Ribstone.scr

SIMPLE TERRAIN INPUTS:

SOURCE TYPE	=	POINT
EMISSION RATE (G/S)	=	0.232000
STACK HEIGHT (M)	=	14.8000
STK INSIDE DIAM (M)	=	1.4020
STK EXIT VELOCITY (M/S)	=	4.2000
STK GAS EXIT TEMP (K)	=	1273.0000
AMBIENT AIR TEMP (K)	=	293.0000
RECEPTOR HEIGHT (M)	=	0.0000
URBAN/RURAL OPTION	=	RURAL
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.

BOUY. FLUX = 15.581 M\*\*4/S\*\*3; MOM. FLUX = 1.995 M\*\*4/S\*\*  
2.

\*\*\* FULL METEOROLOGY \*\*\*

\*\*\*\*\*  
\*\*\* SCREEN AUTOMATED DISTANCES \*\*\*  
\*\*\*\*\*

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

DIST	CONC		U10M	USTK	MIX HT	PLUME	SIGMA
SIGMA	(UG/M**3)	STAB	(M/S)	(M/S)	(M)	HT (M)	Y (M)
(M)	DWASH						
1.13	0.000	1	1.0	1.0	320.0	178.27	1.19
7.81	NO						
14.52	0.1221	3	10.0	10.4	3200.0	27.88	12.69
20.84	NO						
	3.237	3	10.0	10.4	3200.0	27.88	23.92
	NO						
	4.024	3	10.0	10.4	3200.0	27.88	34.60
	NO						

400.	3.745	4	15.0	15.9	4800.0	21.90	29.61
15.56	NO						
500.	3.486	4	10.0	10.6	3200.0	27.55	36.43
18.85	NO						
600.	3.336	4	10.0	10.6	3200.0	27.55	42.96
21.69	NO						
700.	3.109	4	8.0	8.5	2560.0	31.78	49.51
24.69	NO						
800.	2.901	4	8.0	8.5	2560.0	31.78	55.86
27.37	NO						
900.	2.664	4	8.0	8.5	2560.0	31.78	62.14
30.00	NO						
1000.	2.494	4	5.0	5.3	1600.0	44.50	68.73
33.35	NO						
1100.	2.381	4	5.0	5.3	1600.0	44.50	74.86
35.31	NO						
1200.	2.262	4	5.0	5.3	1600.0	44.50	80.95
37.21	NO						
1300.	2.142	4	5.0	5.3	1600.0	44.50	86.99
39.06	NO						
1400.	2.029	4	4.5	4.8	1440.0	48.27	93.10
41.11	NO						
1500.	1.933	4	4.5	4.8	1440.0	48.27	99.05
42.87	NO						
1600.	1.840	4	4.5	4.8	1440.0	48.27	104.98
44.59	NO						
1700.	1.763	4	4.0	4.2	1280.0	52.98	110.98
46.56	NO						
1800.	1.690	4	4.0	4.2	1280.0	52.98	116.83
48.21	NO						
1900.	1.619	4	4.0	4.2	1280.0	52.98	122.65
49.82	NO						
2000.	1.560	4	3.5	3.7	1120.0	59.03	128.60
51.79	NO						
2100.	1.581	5	1.0	1.1	10000.0	85.72	102.06
39.95	NO						
2200.	1.628	5	1.0	1.1	10000.0	85.72	106.28
40.76	NO						
2300.	1.670	5	1.0	1.1	10000.0	85.72	110.50
41.55	NO						
2400.	1.707	5	1.0	1.1	10000.0	85.72	114.69
42.33	NO						
2500.	1.739	5	1.0	1.1	10000.0	85.72	118.88
43.10	NO						
2600.	1.768	5	1.0	1.1	10000.0	85.72	123.05
43.87	NO						
2700.	1.792	5	1.0	1.1	10000.0	85.72	127.21
44.62	NO						
2800.	1.813	5	1.0	1.1	10000.0	85.72	131.36
45.37	NO						
2900.	1.830	5	1.0	1.1	10000.0	85.72	135.49
46.10	NO						
3000.	1.844	5	1.0	1.1	10000.0	85.72	139.61
46.83	NO						

3500.	1.877	5	1.0	1.1	10000.0	85.72	160.04
50.37	NO						
4000.	1.863	5	1.0	1.1	10000.0	85.72	180.20
53.73	NO						
4500.	1.805	5	1.0	1.1	10000.0	85.72	200.11
56.57	NO						
5000.	1.755	6	1.0	1.2	10000.0	72.13	146.59
37.93	NO						

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:  
 278. 4.058 3 10.0 10.4 3200.0 27.88 32.41  
 19.57 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

\*\*\* INVERSION BREAK-UP FUMIGATION CALC. \*\*\*  
 CONC (UG/M\*\*3) = 3.754  
 DIST TO MAX (M) = 2466.65

\*\*\*\*\*  
 \*\*\* SUMMARY OF SCREEN MODEL RESULTS \*\*\*  
 \*\*\*\*\*

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
-----	-----	-----	-----
SIMPLE TERRAIN	4.058	278.	0.
INV BREAKUP FUMI	3.754	2467.	--

\*\*\*\*\*  
 \*\* REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS \*\*  
 \*\*\*\*\*