DISPERSION MODEL GUIDELINES FOR OIL BATTERIES IN THE PROVINCE OF MANITOBA

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1 INTRODUCTION

Background

The Petroleum Branch of Manitoba Industry, Trade and Mines recently introduced amendments to the Drilling and Production Regulation ("the Regulation") dealing with oil batteries. The amendments focus on solution gas management at the batteries relative to emissions of hydrogen sulphide (H_2S) and sulphur dioxide (SO_2). As a follow-up to the amendments, the Petroleum Branch issued *Guidelines for Implementing Regulatory Changes Relating to the Permitting and Operation of Batteries* (Information Notice 02-1) ("the Guidelines"). The objective of the Regulation amendments and the Guidelines is to ensure that the operation of oil batteries does not result in ambient H_2S or SO_2 concentrations that exceed the following maximum acceptable level criteria for these compounds:

	Maximum Acceptable Level	
	1-h average	**24-h average**
H_2S	15 μg/m^3 (11 ppb)	5 μg/m^3 (4 ppb)
SO_2	900 μg/m^3 (0.34 ppm)	300 μg/m^3 (0.11 ppm)

These maximum acceptable level criteria are applicable beyond the battery site.

The Regulation amendments and Guidelines require oil battery operators to demonstrate, using air dispersion modelling, that H_2S and SO_2 emissions will comply with maximum acceptable level ambient criteria. The Petroleum Branch recommends that the U.S. Environmental Protection Agency (US EPA) SCREEN3 dispersion model be used for this purpose.

Modelling Guideline Objective

In response to the need for dispersion modelling, the Petroleum Branch has prepared this *SCREEN3 Dispersion Modelling Guideline* document to assist operators in meeting the expectations expressed in the Regulation and Guidelines. While the US EPA has documentation for the SCREEN3 model, this Modelling Guideline is designed to bridge the gap between the Regulation and Guidelines, and the formal dispersion model documentation. The Modelling Guideline is designed to help regulatory staff, operators and other stakeholders apply the SCREEN3 dispersion model and review the SCREEN3 predictions in the context of the oil battery facilities located in the province of Manitoba.

2 MODELLING OVERVIEW

Dispersion Modelling Background

Dispersion models provide a scientific link between emissions discharged to the atmosphere and associated changes in air chemistry downwind of the discharge. The discharge, once released to the atmosphere is referred to as a plume. Dispersion models can address the following atmospheric processes:

- **Transport:** The downwind location of a plume is determined by the wind direction at plume level.
- **Dispersion:** Thermal and mechanical turbulence processes in the atmosphere dilute the plume as it is carried downwind.
- **Chemistry:** Depending on the pollutant, gas-to-gas or gas-to-particle transformation can take place.
- **Deposition:** The interaction of the plume with precipitation or with surface features such as a tree canopy results in the removal of the pollutant from the air.

These atmospheric processes are represented by mathematical algorithms that are based on a combination of field observations and theoretical considerations. For convenience, these relationships have been incorporated into computer code, which is referred to as a "computer model".

Dispersion Model Input

To replicate these atmospheric processes, the models require information that can be broadly classified as follows:

- **Source:** Pollutant streams are frequently discharged to the atmosphere through a stack with a considerable vertical velocity or a high temperature. The resulting plume will tend to rise due to associated momentum and/or buoyancy effects. To replicate the initial behaviour (i.e., plume rise), parameters such as stack height, stack diameter, exit velocity and exit temperature are required.
- **Meteorology:** Meteorology controls the transport and dispersion of the plume as it is carried downwind. Important meteorological parameters include wind direction, wind speed, atmospheric turbulence and mixing height.
- **Terrain:** Terrain features can modify the horizontal trajectory by steering, channelling, and blocking the airflow. For example, a plume emitted in a valley can be confined to the valley and transported along the valley axis. A plume passing over elevated terrain may, in the extreme, impinge on the elevated terrain feature. Rough terrain, in conjunction with surface features such as a tree canopy can increase atmospheric turbulence.

Dispersion Model Output

The dispersion model output can be comprised of the following:

- Concentration predictions for specified receptor locations.
- An echo of the input parameters to confirm and to provide a record of the input parameters.
- Predictions of other parameters such as plume height or dispersion coefficients that can be used to help interpret the predicted concentrations.

The model calculates maximum concentrations that can be compared to the maximum ambient air quality criteria in order to determine acceptability. In the event that the maximum predicted values are greater than the criteria, the model can be re-run with modified source parameters to determine operating parameters that will meet the objectives.

Dispersion Model Types

Dispersion models can be categorized according to the complexity of the meteorological input as follows:

- **Event.** This approach calculates ambient concentrations for an event defined by a single set of source and meteorological conditions. The duration of an event is typically of the order of one hour. The event mode is used either to help explain a single observation or to help determine model performance.
- **Screening.** This approach calculates concentrations for a wide range of meteorological conditions. The meteorological conditions are typically pre-selected by the model.
- **Sequential Time Series.** This approach is used to simulate air quality changes on an hour-by-hour basis using a representative year of hourly average meteorological data (8760 h). The approach creates an hourly average concentration file for all source/receptor combinations. The hourly average concentration file can then be used to determine average concentrations for periods that are multiples of one-hour.

SCREEN3 Model Overview

The US EPA developed the SCREEN dispersion model to provide an easy-to-use method of obtaining pollutant concentrations. The current version of the model is SCREEN3, Version 3.0 of the SCREEN model. The SCREEN3 model can be used to:

- Determine the maximum ground-level pollutant concentrations downwind for a wide range of meteorological conditions.
- Address dispersion in rural and urban areas.

- Include the effects of building downwash.
- Address terrain effects.

The model focuses primarily on predicting 1-hour average concentrations from a single source. Post-processing of the model output can be undertaken to determine concentrations for other averaging periods and for multiple sources. More detailed US EPA supported models such as ISCST3, AERMOD and CALPUFF address multiple sources, elevated terrain and different averaging periods in a more rigorous manner.

Documentation for the SCREEN3 model include the following reports:

- **SCREEN2 Model User's Guide**. EPA document EPA-450/4-92-006. Prepared by the US Environmental Protection Agency (September 1992).
- **Screening Procedures for Estimating the Air Quality Impact of Stationary Sources**. EPA document EPA-454/R 92-019. Prepared by the US Environmental Protection Agency (October 1992).
- **SCREEN3 Model User's Guide**. EPA document EPA-454/B-95-004. Prepared by the US Environmental Protection Agency (September 1995).

The SCREEN3 model code, executable file, support documentation and sample input/output files are available from the US EPA Support Centre for Regulatory Models (SCRAM) website (www.ttn.epa.gov/scram).

MS-DOS Version of SCREEN3

The SCRAM version of the model is not Windows compatible and has to be run under a MS-DOS Window (for Windows 95 or 98). For Windows 2000, the MS-DOS window is referred to as the "Command Prompt" Window. Features of the MS-DOS version of the model are as follows:

- The user responds to a series of questions to provide the input data and to select the model options (e.g., Figure 2.1). The user cannot check or change the input without starting from the beginning.
- The SCREEN3 executable file creates an input file named SCREEN.DAT and an output file named SCREEN.OUT for each version. The user has no control over the naming of these files.
- A third-party text editor or word processing package is used to view, archive and print the model output.

While full functionality is available through the MS-DOS version, the interface does not meet contemporary graphical user interface (GUI) expectations established by mainstream Windows programs.

Windows Version of SCREEN3

Given the widespread and associated frequent use of the SCREEN3 model, Windows based GUIs for the model are commercially available from the following sources:

- **Lakes Environmental** (450 Phillip Street — Suite 2, Waterloo, Ontario, N2L 5J2, Canada. Telephone: 519-746-5995). The Lakes Environmental website is www.lakes-environmental.com. Their SCREEN3 interface is referred to as SCREEN View.
- **Trinity Consultants** (12801 North Central Expressway, Suite 1200, Dallas, TX 75243-1791, U.S.A.). Telephone: 919-549-0499). Their software website is www.breeze-software.com.
- **BEE-Line Software** (P.O. Office 7348, Ashville, NC 28802, U.S.A. Telephone: 828-628-0636). The BEE-Line website is www.beeline-software.com.

All three suppliers provide Windows interfaces for air quality models that include SCREEN3. The advantages of the Window's interface versions include:

- Integrated model input and execution.
- Post-processing of data provides a concentration versus distance plot.
- Ability to review, check and modify input parameters prior to execution.
- Ability to handle Metric and English units.
- Context sensitive Help features.

Figure 2.2 provides an example of one of the SCREEN View input windows.

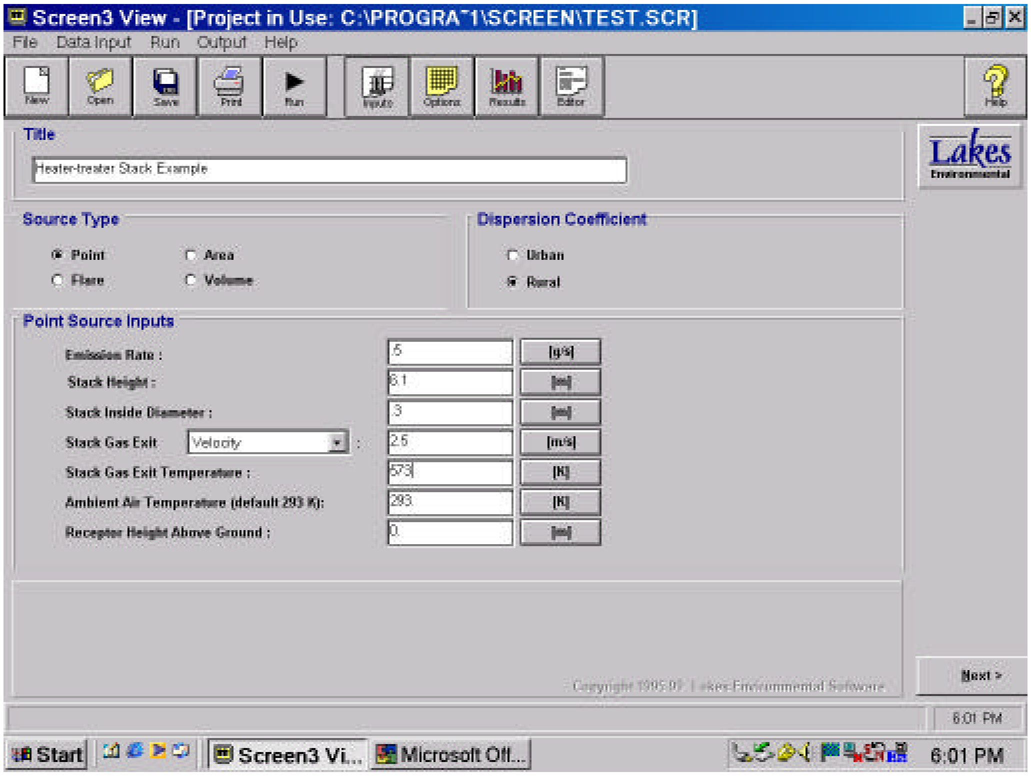
SCREEN 3 Output Interpretation

Regardless of whether Windows or MS-DOS versions of the model are used, SCREEN3 produces the same output (Figure 2.3). The user typically will confirm the input parameters and view the concentration profile. The maximum predicted value is then compared to the maximum ambient acceptable level criteria.

Figure 2. 1 An example of the MS-DOS input procedure**.**

```
C:\DOCUME~1\mervyn\MYDOCU~1\SCREEN3\SCREEN3.EXE
 ******  SCREEN3 MODEL  ******
 **** VERSION DATED 96043 ****

ENTER TITLE FOR THIS RUN (UP TO 79 CHARACTERS):
Heater-treater Stack Example

ENTER SOURCE TYPE: P    FOR POINT
                   F    FOR FLARE
                   A    FOR AREA
                   V    FOR VOLUME
   ALSO ENTER ANY OF THE FOLLOWING OPTIONS ON THE SAME LINE:

     N    - TO USE THE NON-REGULATORY BUT CONSERVATIVE BRODE 2
            MIXING HEIGHT OPTION.
     nn.n - TO USE AN ANEMOMETER HEIGHT OTHER THAN THE REGULATORY
            (DEFAULT) 10 METER HEIGHT.
     SS   - TO USE A NON-REGULATORY CAVITY CALCULATION ALTERNATIVE
  Example - PN 7.0 SS (entry for a point source)

 ENTER SOURCE TYPE AND ANY OF THE ABOVE OPTIONS:
p
ENTER EMISSION RATE (G/S):
0.5
ENTER STACK HEIGHT (M):
6.1
ENTER STACK INSIDE DIAMETER (M):
0.3
ENTER STACK GAS EXIT VELOCITY OR FLOW RATE:
OPTION 1 : EXIT VELOCITY (M/S):
 DEFAULT - ENTER NUMBER ONLY
OPTION 2 : VOLUME FLOW RATE (M**3/S):
           EXAMPLE "VM=20.00"
OPTION 3 : VOLUME FLOW RATE (ACFM):
           EXAMPLE "VF=1000.00"
2.5
ENTER STACK GAS EXIT TEMPERATURE (K):
573
ENTER AMBIENT AIR TEMPERATURE (USE 293 FOR DEFAULT) (K):
293
ENTER RECEPTOR HEIGHT ABOVE GROUND (FOR FLAGPOLE RECEPTOR) (M):
0
ENTER URBAN/RURAL OPTION (U=URBAN, R=RURAL):
R
CONSIDER BUILDING DOWNWASH IN CALCS?  ENTER Y OR N:
N
USE COMPLEX TERRAIN SCREEN FOR TERRAIN ABOVE STACK HEIGHT?
ENTER Y OR N:
N
USE SIMPLE TERRAIN SCREEN WITH TERRAIN ABOVE STACK BASE?
ENTER Y OR N:
N
ENTER CHOICE OF METEOROLOGY;
1 - FULL METEOROLOGY (ALL STABILITIES & WIND SPEEDS)
2 - INPUT SINGLE STABILITY CLASS
3 - INPUT SINGLE STABILITY CLASS AND WIND SPEED
1
USE AUTOMATED DISTANCE ARRAY? ENTER Y OR N:
Y
ENTER MIN AND MAX DISTANCES TO USE (M):
100 50000
```

Figure 2. 2 An example of the SCREEN View input windows.



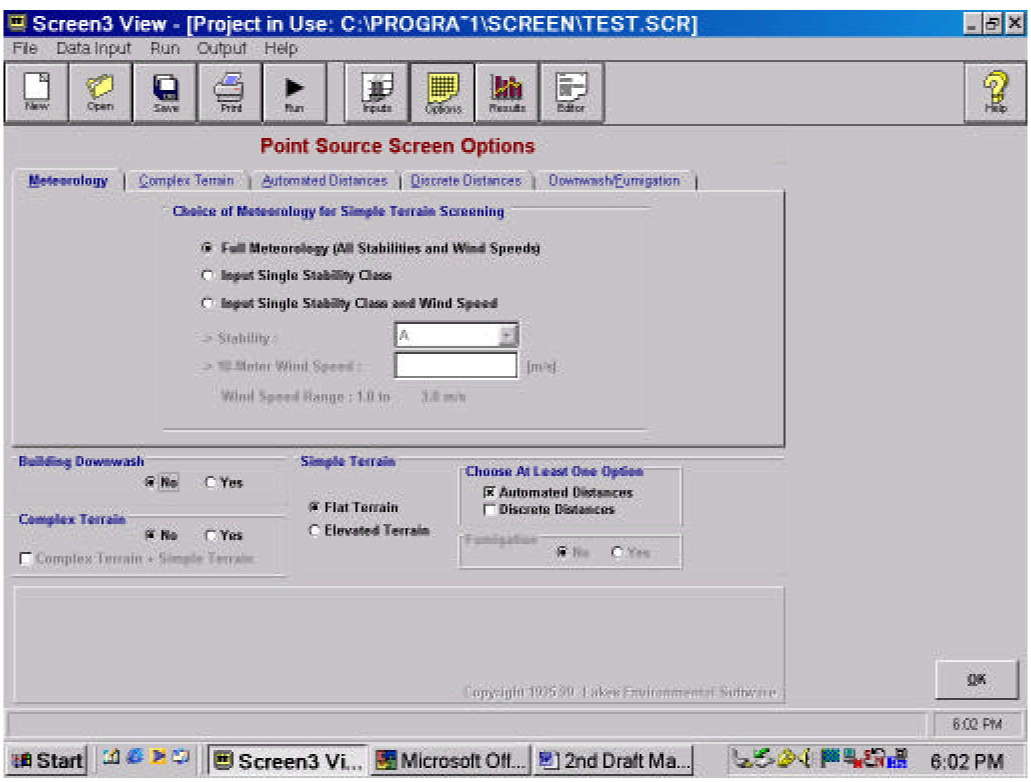


Figure 2. 3 An example of the SCREEN3 model output.

```
                                                                02/03/02
                                                                18:03:59
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Heater-treater Stack Example

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HEIGHT (M)       =       6.1000
   STK INSIDE DIAM (M)    =        .3000
   STK EXIT VELOCITY (M/S)=       2.5000
   STK GAS EXIT TEMP (K)  =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =     .270 M**4/S**3;  MOM. FLUX =     .072 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
   (M)    (UG/M**3)   STAB  (M/S)  (M/S)    (M)    HT (M)   Y (M)   Z (M)  DWASH
-------  ----------   ----  -----  -----  ------   ------  ------  ------  -----
   100.   357.7        3     1.5    1.5   480.0    11.44   12.56    7.60    NO
   200.   326.5        4     1.5    1.5   480.0    11.44   15.64    8.64    NO
   300.   294.8        4     1.0    1.0   320.0    14.11   22.73   12.31    NO
   400.   229.7        4     1.0    1.0   320.0    14.11   29.54   15.44    NO
   500.   177.8        4     1.0    1.0   320.0    14.11   36.22   18.44    NO
   600.   140.1        4     1.0    1.0   320.0    14.11   42.78   21.33    NO
   700.   112.8        4     1.0    1.0   320.0    14.11   49.24   24.14    NO
   800.   101.1        6     1.0    1.0 10000.0    22.03   28.01   12.81    NO
   900.   103.1        6     1.0    1.0 10000.0    22.03   31.11   13.76    NO
  1000.   102.8        6     1.0    1.0 10000.0    22.03   34.19   14.68    NO
  1100.   100.4        6     1.0    1.0 10000.0    22.03   37.24   15.50    NO
  1200.   97.28        6     1.0    1.0 10000.0    22.03   40.27   16.31    NO
  1300.   93.72        6     1.0    1.0 10000.0    22.03   43.28   17.09    NO
  1400.   89.96        6     1.0    1.0 10000.0    22.03   46.27   17.85    NO
  1500.   86.15        6     1.0    1.0 10000.0    22.03   49.24   18.60    NO
  1600.   82.38        6     1.0    1.0 10000.0    22.03   52.19   19.33    NO
  1700.   78.72        6     1.0    1.0 10000.0    22.03   55.13   20.04    NO
  1800.   75.19        6     1.0    1.0 10000.0    22.03   58.05   20.74    NO
  1900.   71.83        6     1.0    1.0 10000.0    22.03   60.95   21.43    NO
  2000.   68.63        6     1.0    1.0 10000.0    22.03   63.84   22.10    NO
  2100.   65.62        6     1.0    1.0 10000.0    22.03   66.71   22.67    NO
  2200.   62.80        6     1.0    1.0 10000.0    22.03   69.57   23.23    NO
  2300.   60.16        6     1.0    1.0 10000.0    22.03   72.42   23.78    NO
  2400.   57.69        6     1.0    1.0 10000.0    22.03   75.26   24.32    NO
  2500.   55.37        6     1.0    1.0 10000.0    22.03   78.08   24.85    NO
  2600.   53.19        6     1.0    1.0 10000.0    22.03   80.89   25.36    NO
  2700.   51.15        6     1.0    1.0 10000.0    22.03   83.69   25.87    NO
  2800.   49.22        6     1.0    1.0 10000.0    22.03   86.48   26.38    NO
  2900.   47.41        6     1.0    1.0 10000.0    22.03   89.27   26.87    NO
```

```
  3000.   45.70        6     1.0     1.0 10000.0   22.03   92.04    27.36     NO
  3500.   38.70        6     1.0     1.0 10000.0   22.03  105.75    29.34     NO
  4000.   33.35        6     1.0     1.0 10000.0   22.03  119.26    31.17     NO
  4500.   29.16        6     1.0     1.0 10000.0   22.03  132.58    32.89     NO
  5000.   25.81        6     1.0     1.0 10000.0   22.03  145.74    34.51     NO
  5500.   23.07        6     1.0     1.0 10000.0   22.03  158.76    36.05     NO
  6000.   20.80        6     1.0     1.0 10000.0   22.03  171.64    37.51     NO
  6500.   18.90        6     1.0     1.0 10000.0   22.03  184.40    38.91     NO
  7000.   17.27        6     1.0     1.0 10000.0   22.03  197.05    40.26     NO
  7500.   15.92        6     1.0     1.0 10000.0   22.03  209.59    41.41     NO
  8000.   14.74        6     1.0     1.0 10000.0   22.03  222.03    42.53     NO
  8500.   13.71        6     1.0     1.0 10000.0   22.03  234.38    43.60     NO
  9000.   12.80        6     1.0     1.0 10000.0   22.03  246.65    44.63     NO
  9500.   11.99        6     1.0     1.0 10000.0   22.03  258.83    45.63     NO
 10000.   11.27        6     1.0     1.0 10000.0   22.03  270.94    46.61     NO
 15000.   6.867        6     1.0     1.0 10000.0   22.03  388.45    55.07     NO
 20000.   4.917        6     1.0     1.0 10000.0   22.03  500.97    60.47     NO
 25000.   3.791        6     1.0     1.0 10000.0   22.03  609.77    65.02     NO
 30000.   3.064        6     1.0     1.0 10000.0   22.03  715.60    68.99     NO
 40000.   2.219        6     1.0     1.0 10000.0   22.03  920.23    74.63     NO
 50000.   1.728        6     1.0     1.0 10000.0   22.03 1117.43    79.32     NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   100.   357.7        3     1.5     1.5   480.0   11.44   12.56     7.60     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         MAX CONC    DIST TO    TERRAIN
  PROCEDURE         (UG/M**3)    MAX (M)     HT (M)
--------------    -----------    -------    -------
SIMPLE TERRAIN       357.7          100.         0.

***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

3 EMISSION SOURCE CHARACTERIZATION

Emission Source Background

There are about 80 oil batteries in the province of Manitoba. Characteristics of these batteries include:

- Oil production can range from 1 to 180 m^3/d.
- The typical water-to-oil ratio is 10 m^3 water per m^3 oil.
- Gas to oil ratios vary from 5 to 65 m^3 of solution gas (as a gas at NTP) per m^3 oil (as a liquid).
- H_2S concentrations in the solution gas can range from <0.01% to 13.5%.

The solution gas for these facilities is variously used as process fuel, flared, incinerated or vented. The disposal method depends on the battery and on the volume of gas produced.

As the solution gas can contain varying amounts of hydrogen sulphide (H_2S), associated combustion of the solution gas will result in sulphur dioxide (SO_2) emissions. The direct venting of H_2S emissions to the atmosphere results in a potential for odours due to a relatively low odour threshold for H_2S.

Figure 3.1 represents a typical oil battery processing schematic showing locations for potential air emissions. The following are noted:

- The well fluids enter a free-water knockout separator where any liquid water that is not in an emulsion is removed and directed to an on-site water storage tank.
- A heater-treater is used to separate the oil-water emulsion. During this heating process most of the solution gas is flashed. This gas can be collected and be used to fire the heater-treater (i.e., used as process gas), directed for disposal through a flare stack or directed to the storage tanks.
- The recovered water is directed to the water storage tank and the oil is directed to an oil storage tank.
- Residual amounts of solution gas often remain in the water and the oil product. As a consequence, the solution gas can collect in the headspace of both tanks and vent directly to the atmosphere through the tank vents, or be collected by a vapour recovery system and used as process fuel or directed to the flare stack

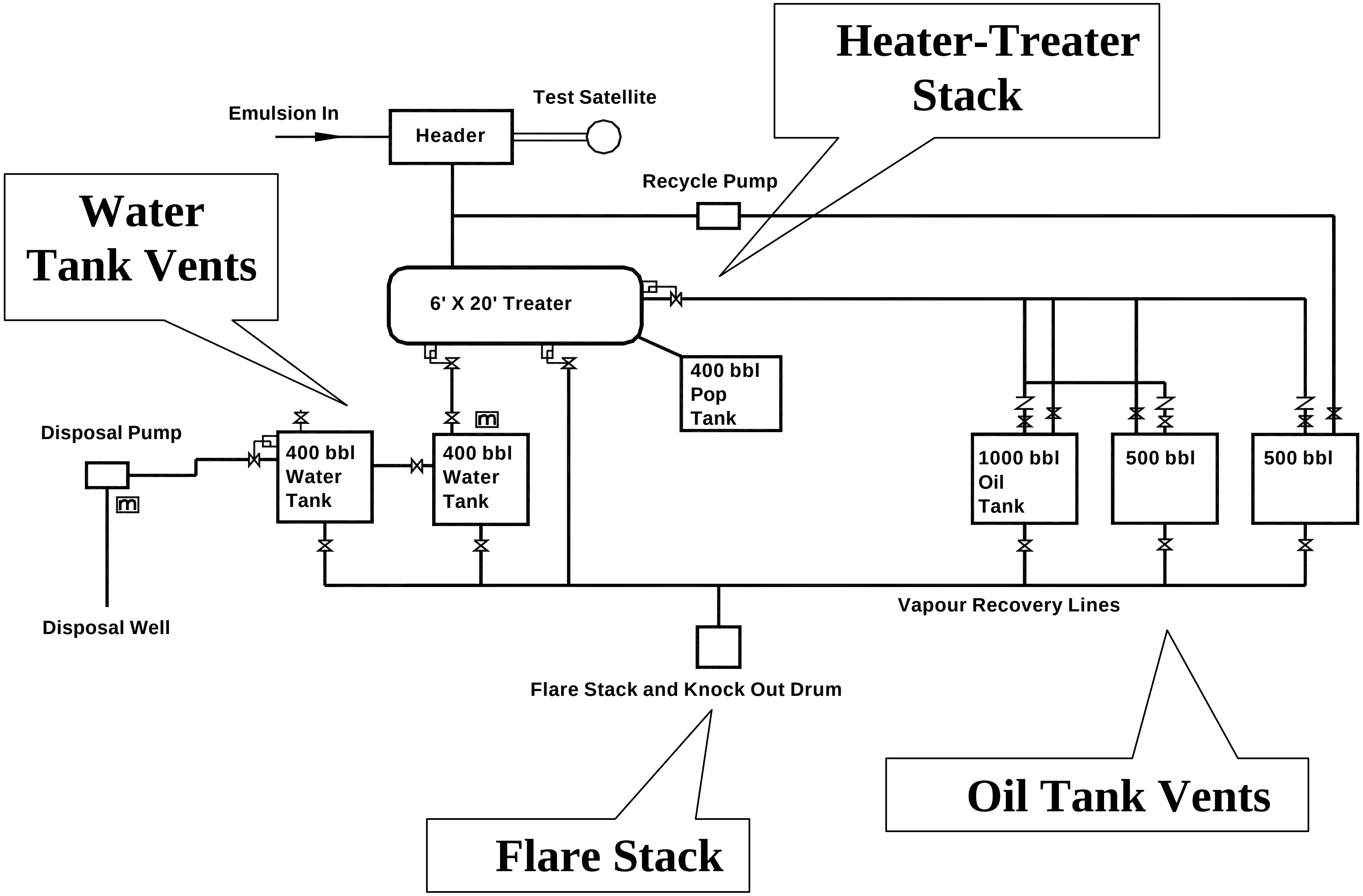


Figure 3.1 Potential emission sources associated with Manitoba oil batteries.

In summary, the two primary source types are as follows:

- **Combustion sources** that include the use of the solution gas as a process gas or the flare. In this case, the H_2S in the solution gas is converted to SO_2. Ambient SO_2 concentrations are likely to be of a lesser concern than H_2S since the combustion products will be buoyant and rise, and the odour threshold for SO_2 is much greater than that for H_2S.
- **Direct venting** of solution gas will not have the benefit of a buoyant plume rise and the low odour threshold for H_2S has the potential to produce odours.

SCREEN3 Emission Source Types

The SCREEN3 model defines the following source types that depend on the physical characteristics of the release:

- A Point source is an isolated stack or vent that is typically defined by a pipe that is oriented vertically with a circular cross section (e.g., a stack). Gas flow from a point source is characterized by an exit velocity and an exit temperature. For combustion sources, the products of combustion can be significantly warmer than ambient (e.g., 300 °C). For non-combustion sources, the exit temperature can be near ambient (e.g., about 18 °C).
- A Flare source is a specialized point source where the combustion takes place at the stack tip. The products of combustion are significantly warmer than ambient (e.g., 1000 °C).
- An Area source is a ground-based source where the emissions can be assumed to originate from a defined area. Examples include evaporation of hydrocarbons from an impoundment pond or emissions from a landfill site. The emissions are assumed to be at the ambient temperature.
- A Volume source is used to represent a diffuse source with an initial size. Examples include dust emissions from a storage pile or fugitive gas emissions from an industrial facility. Emissions are assumed to be at the ambient temperature.

Table 3.1 identifies the parameters required to characterize these respective source types. The table also indicates the respective metric units. The Point source option can be used to represent a heater-treater stack, incinerator stack, a flare stack and a tank vent. The Flare source option can be used to represent a flare pit or a flare stack. Area and Volume sources are not normally applicable to the type of sources associated with an oil battery.

Table 3. 1 Input parameters required to represent each source type.

Point Source

Parameter	Description	Units
Emission Rate	Mass emission rate of the pollutant (i.e., SO_2 or H_2S).	g/s
Stack Height	Stack height above plant grade.	m
Stack Inside Diameter	Inside diameter.	m
Stack Gas Exit Velocity	Exit velocity based on the volumetric flow rate.	m/s
Stack Gas Exit Temperature	Temperature of the gas released.	K
Ambient Air Temperature	Use the default value of 293 K for non- flares. Use 288 K for flare stacks. Use exit temperature for non-buoyant releases.	K
Receptor Height Above Ground	For ground level, use 0 m. Can be non-zero to represent a balcony or a roof.	m

Flare Source

Parameter	Description	Units
Emission Rate	Mass emission rate of the pollutant (i.e., SO_2).	g/s
Flare Stack Height	Stack height above plant grade.	m
Stack Inside Diameter	Inside diameter.	m
Total Heat Release	Total heat release due to the combustion of the gas stream to flare.	cal/s
Receptor Height Above Ground	For ground level, use 0 m. Can be non-zero to represent a balcony or a roof.	m

Area Source

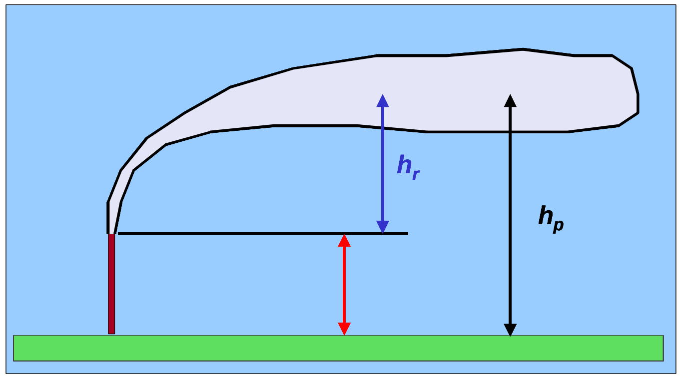
Parameter	Description	Units
Emission Rate	Mass emission rate of the pollutant per unit area (i.e., H_2S).	$g/m^2/s$
Source Release Height	Release height above ground.	m
Length	Larger side of a rectangular source.	m
Width	Smaller side of a rectangular source.	m
Receptor Height Above Ground	For ground level, use 0 m. Can be non-zero to represent a balcony or a roof.	m
Search through a range of wind direction?	Select Yes. SCREEN3 will consider a range of wind direction orientations relative to the rectangular source.	-

Volume Source

Parameter	Description	Units
Emission Rate	Mass emission rate of the pollutant (i.e., H_2S)	g/s
Source Release Height	Release height above ground.	m
Initial Lateral Dimension	Rectangular length ÷ 4.3.	m
Initial Vertical Dimension	Vertical dimension ÷ 2.15.	m
Receptor Height Above Ground	For ground level, use 0 m. Can be non-zero to represent a balcony or a roof.	m

Combustion Emission Sources

The primary combustion products due to a hydrocarbon fuel stream include carbon dioxide and water vapour from the hydrocarbons, and nitrogen from the entrained air. The products of combustion are much warmer than the ambient air and will rise. The increased plume height (h_p) given by the sum of the physical stack height (H_p) and the plume rise (h_r) will have the beneficial effect of reducing ground-level concentrations.



For the purposes of this Modelling Guideline, the primary combustion pollutant of concern is sulphur dioxide (SO_2) that results from the combustion of hydrogen sulphide (H_2S) in the fuel stream.

Heater-treater Stack Emissions

To replicate the plume rise from a heater-treater, the stack exit temperature and exit velocity are required. The volumetric flow rate of the products of combustion, which includes the entrained air will depend on:

- Fuel consumption rate. Can be obtained from manufacturer specifications, i.e., the design heat output and heat exchanger efficiency.
- Fuel composition. Can be obtained from battery fuel gas analyses.
- Operating parameters. The amount of excess air will affect the exit temperature and the flow rate.
- The completeness of the combustion. For the purposes of calculating plume rise, 100% combustion can be assumed.

Mass and energy balance calculations can be used to estimate the stack exit temperature (°C) and the total volumetric stack gas flow rate (m^3/s).

The stack exit temperature (T_s) required by SCREEN3 will be given by:

$$T_s(K) = T_s(°C) + 273.15$$

The exit velocity (V_s) required by SCREEN3 will be given by:

$$V_s(\mathrm{m/s}) = \frac{Q_r(\mathrm{m^3/s})T_s(\mathrm{K})}{p\ R_s^2(\mathrm{m^2})T_r(\mathrm{K})}$$

where:

Q_r = stack gas flow rate at reference conditions (m^3/s)
R_s = stack tip exit radius (m)
T_r = reference temperature for Q_r (typically T_r = 288 K).

The SO_2 release rate is based on the reaction:

$$H_2S + 3/2\ O_2 \Rightarrow SO_2 + H_2O$$

Complete combustion assumes that 1 kmole of H_2S produces 1 kmole of SO_2. On a volumetric basis 1 m^3 of H_2S produces 1 m^3 of SO_2. On a mass basis, 1 kg of H_2S produces 1.880 kg of SO_2, this result is based on a molecular mass of 34.076 for H_2S and a molecular mass of 64.059 for SO_2.

Combustion calculations to determine exit velocity and SO_2 release rates are normally based on current or proposed maximum flow rate conditions. If the actual flow rate and H_2S values are much less than the maximum rates, then representative values at the normal operating conditions may be required in addition to the maximum values.

The stack height (m) and diameter (m) can be determined from on-site measurements or from as-built engineering drawings. The stack height is relative to grade and the diameter refers to the inside stack tip diameter.

Flare Stack Emissions

The primary difference between a heater-treater and the flare results from the location where the combustion takes place. For a heater-treater, the combustion takes placed in an appropriately designed combustion chamber prior to having the combustion products enter the stack. For a flare, the combustion takes place at the stack tip in the atmosphere.

A portion of the heat release at the flare tip will by lost by radiation while the remaining amount will heat the products of combustion and the entrained air. The plume rise will therefore depend on the fraction of heat radiated. Depending on the flare type, the fraction of heat loss can range from the 10 to 15% range for a pure hydrogen or methane flame to 55% reported in a gas flare accompanied by an oil spray to produce a visible plume.

Two methods are available to replicate a flare stack with the SCREEN3 model:

- The first method uses the Flare option that requires the total heat release (cal/s) and the SO_2 emission rate (g/s). The SO_2 emission rate is calculated in the same manner as for a process heater-treater (i.e., assuming complete conversion of H_2S in the fuel to SO_2). The SCREEN3 flare option assumes 55% heat radiation, leaving 45% contributing to plume rise.
- The second method uses the Point option with pseudo stack parameters that are selected to represent the same plume rise that would result from the Flare option. By using pseudo parameters, a different radiation assumption can be adopted. Specifically, a radiation value of 25% has been adopted elsewhere as being more representative. This assumption assumes 75% of the energy content contributes to the plume rise, resulting in a larger rise and smaller ground level concentrations relative to the 55% assumption.

The second method is recommended and a spreadsheet has been supplied to calculate the pseudo parameters based on the gas stream flow rate and the composition. The spreadsheet can account for two gas streams to obtain the required parameters for the combined gas stream.

Recent research has indicated that minimum heats of combustion in the 12 to 20 MJ/m^3 range is required to ensure a stable flame. In some cases, a higher heat content gas can be required to ensure that the combined gas stream meets the minimum. As solution gas streams in Manitoba typically have heating values greater than 30 MJ/m^3, the addition of a higher heat content gas is not required.

Flare Pit Emissions

A ground based flare would behave in a manner similar to that of an elevated flare without the advantage of an initial stack height. As a consequence the same approach can be adopted for a ground flare as for a regular flare with the exception that the physical stack height is set to 0 m.

Flare Spreadsheet

A spreadsheet has been prepared (in Microsoft Excel format) to calculate pseudo stack parameters (Figure 3.2). The user is required to provide the following:

- Flow rate of gas stream to flare.
- Composition of gas stream to flare.
- Flare stack height.
- Flare stack tip diameter.

The spreadsheet provides the following parameters to be used as input for the Point option:

Figure 3. 2 Flare stack spreadsheet.

Sour Gas Flare Properties

Company	ABC oil
Facility	Battery Example
Case	Solution Gas Falring

Flow Rate

Gas Stream	Solution	None	To Flare	
Flow Rate	0.500	0.000	0.500	10^3 m³/d at 15°C and 101.3 kPa
Percentage	100.0	0.0	100.0	%
Reference Temp	15	15	15	°C

Composition (dry)

H_2	0.0000		0.0000	Mole Fraction
He	0.0004		0.0004	
N_2	0.1485		0.1485	
CO_2	0.0693		0.0693	
H_2S	0.0139		0.0139	
C_1	0.1085		0.1085	
C_2	0.2620		0.2620	
C_3	0.2511		0.2511	
iC_4	0.0325		0.0325	
nC_4	0.0710		0.0710	
iC_5	0.0154		0.0154	
nC_5	0.0139		0.0139	
C_6	0.0080		0.0080	
C_7+	0.0055		0.0055	
Total	1.0000	0.0000	1.0000	

Gas Stream Properties

Molecular Mass	37.75	0.00	37.75	kg/kmole
Net Heating Value	59.55	0.00	59.55	10^6 m³/d at 15°C and 101.3 kPa
Net Heat Release Rate	82,314	0	82,314	cal/s
Equivalent SO_2 Inlet	0.019	0.000	0.019	t/d
Equivalent SO_2 Inlet	0.22	0.00	0.22	g/s

Stack Parameters

Flare Stack Height	5.0	m	
Flare Stack Diameter	76.00	mm	
Actual Exit Velocity	1.28	m/s	
Length of Flame:	1.29	m	
Heat Intensity at Base	1.23	kW/m²	Background = 1.04 kW/m²
Conversion Efficiency	100.00	%	
Radiation Loss	25	%	(Brode => 55%, AENV => 25%)
Sensible Heat Release	61,736	cal/s	Based on conversion efficiency & radiation loss

Model Input Parameters

Effective Stack Height	6.02	m	(per EPA and Beychok,M.; 1979)
Pseudo-diameter	**0.972**	**m**	based on actual exit velocity
Actual Exit Velocity	1.28	m/s	
Exit Temperature	1273	K	1000 °C
Ambient temperature	288	K	Pseudo temperature for modelling

Emissions

SO_2 Emission	0.218	g/s	Based on user-specified conversion efficiency
H_2S 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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Version 5 (Compatible with EUB Spreadsheet)

- The pseudo stack height (m) is based on the sum of the physical stack height and the flame height.
- A pseudo stack gas temperature of 1000 °C is assumed.
- The actual exit velocity (m/s) based on the gas flow rate to the flare and the flare tip cross-sectional area.
- A pseudo diameter (m) based on ensuring the flare plume height is equivalent to that associated with a conventional stack.
- An ambient temperature of 288 K. Regardless of the meteorological conditions, the user has to use this ambient temperature when using the Point option for a flare stack.
- The SO_2 emission rate (g/s).

For the regulatory purposes, the combustion conversion is assumed to be 100% and the radiation heat loss is assumed to be 25%.

Non-combustion Sources

A non-combustion gas stream vented to the atmosphere tends to be near ambient temperature and/or at a low velocity. As a consequence a non-combustion release will experience minimal benefits of plume rise. For the purposes of this guideline, the primary pollutant of interest is H_2S that is contained in the solution gas.

Heater-treater Off Gas

During a process upset condition, the treater gas may be vented directly to the atmosphere without the benefit of combustion. This will result in the following:

- The pollutant of interest being H_2S since none of the H_2S will be converted to SO_2.
- Minimal plume rise.

Nonetheless, the <u>Point</u> source characterization parameters for this case will be required. It should be noted that the volume and composition of the gas that is flashed from the heater-treater may not be the same as that derived from upstream solution gas sampling or gas-to-oil ratios. The composition and release rate can be determined from process simulation models.

Tank Vents

Residual solution gas will be released from the oil in the oil product tank and to a lesser extent, from the water in the water storage tank. There are also facilities where excess treater gas is directed to the oil product tank. The solution gas in the respective tank headspaces can be assumed to be in equilibrium with the tank liquid. For facilities without a vapour recovery system, the headspace gas is released to the atmosphere when:

- The tank is filling which will force the gas out the vent by displacement.

- The exterior of the tank is heated due to solar radiation during the day, causing the gas in the headspace to expand.

When the tank is being drained or during the night, the tank will be entraining ambient air into the headspace. The composition of the gas in the headspace will differ from that of the solution gas and can be determined by process simulation models.

In terms of initial dispersion, the emissions from the tank vents will differ from those associated with a Point source for two reasons:

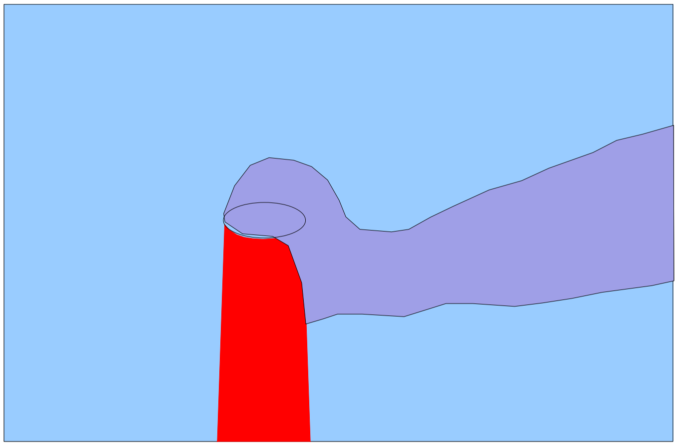
- The tank gases will not benefit from any significant plume rise since they will be released at near ambient temperature and the exit velocity will be extremely low.
- The tank structure can potentially create a turbulent wake downwind which can entrain the released gases.

For facilities with a vapour recovery system, the tank vapours are collected and used as process gas and/or directed to the flare.

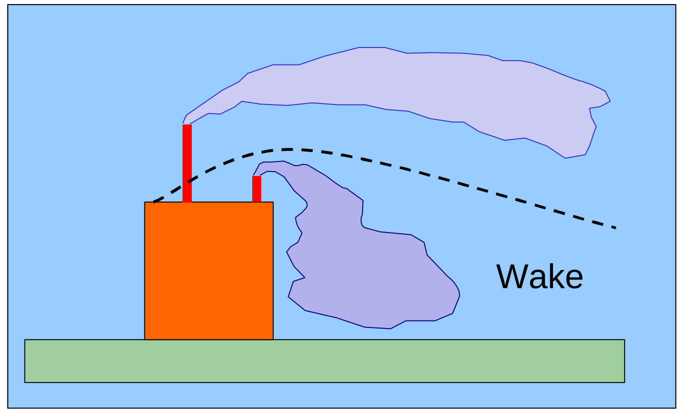
Local Aerodynamic Effects

Local aerodynamic effects may have adverse influences on the plume rise and dispersion. Specifically:

- For high wind speed, low exit velocity conditions, the plume can be partially entrained into a low-pressure wake that develops in the lee of the stack.



- Under certain atmospheric conditions, a building wake cavity can be produced downwind of a building. A plume can be entrained into this wake cavity resulting in localized high concentrations. Even if the plume escapes entrainment into the cavity, the cavity wake effects can influence the plume rise and dispersion.



Stack Tip Downwash

Stack tip downwash effects on plume rise are incorporated into the SCREEN3 model for Point sources. The stack tip downwash can be avoided by designing the stack to ensure a relatively high exit velocity (i.e., 10 m/s). The user has no control of this option.

Building/Structure Wake

If a Point or Flare source is located near a building or other structure, the user should enter the building/structure dimensions. For the most part, wake effects associated with flare stacks can be ignored due to the separation between the flares and buildings. This separation is due to safety considerations. Combustion and non-combustion Point sources, however, can be located adjacent to a building or some other structure. A tank, for example, can be viewed as a wake generating structure for the purposes of evaluating tank vent emissions.

Buildings need to be considered if the source is located within a distance equal to 5 building heights. If the source release height is greater than 2.5 times the building height then the building effects can be ignored. As storage tanks are typically 6 m high, all tank vent emission will be subject to structure wake effects and many nearby heater-treater stacks may also be subject to these effects. The SCREEN3 model requires the following:

- Building height (m)
- Maximum horizontal building/structure dimension (m)
- Minimum horizontal building/structure dimension (m)

For vertical oriented cylindrical product storage tanks, the tank diameter is used for the maximum and minimum horizontal dimensions.

Multiple/ Overlapping Sources

The SCREEN3 model can only predict concentrations downwind from a single source. Emissions from multiple sources within a single battery or from two or more batteries in the same area (i.e., within a few kilometres of each other) can overlap.

Plumes from overlapping sources that emit the same pollutant can combine to produce ambient concentrations that are greater than those resulting from a single source. While multiple source dispersion models such as ISCST3, AERMOD or CALPUFF can handle overlapping plumes rigorously, the SCREEN3 model can be used to provide a first order estimate. The more rigorous models account for the source separation distances and the alignment due to site-specific winds.

Overlapping Method 1

The simplest method is to run the full meteorology option for each source and add the individual maximum predicted concentrations to determine a combined maximum value. This approach assumes the sources are similar in nature and are collocated. As the maximum predicted value for each source is often associated with a unique meteorological condition, the individual maxima may not occur with the same condition. As a consequence, the sum will be conservative in that the individual maxima may not occur at the same time.

Overlapping Method 2

Sources that emit the same pollutant from several stacks in a common facility (e.g., a heater-treater stack and a flare stack) can be analysed by assuming all the emissions originate from a single representative stack. For each stack compute the parameter M:

$$M = \frac{H_s(m)\ \ Q_s(m^3/s)\ \ T_s(K)}{P(g/s)}$$

where: H_s = stack height (m)
Q_s = stack gas volumetric flow rate *at stack conditions* (m^3/s)
Ts = stack gas exit temperature (K)
P = pollutant flow rate (g/s)

The parameter M accounts for the relative importance of the plume height and the emissions rate. The stack that has the lowest parameter M is used as the representative stack. Specifically, the stack height, diameter, exit velocity and exit temperature for the stack with the lowest M value is used as input into the SCREEN3 model.

The pollutant flow rate for the SCREEN3 model is taken as follows:

$$P = P_1 + P_2 + \ldots P_n$$

which is the sum of all pollutant flow rates for all the individual stacks.

The above approach essentially assumes that the pollutant flow rates for the representative stack are additive and that the physical and plume rise parameters are associated with the source with the lowest expected plume height. This conservative assumption will overstate the predicted values.

Overlapping

The above approaches are likely to be extremely conservative for

Comment dissimilar stacks and if the sources are located more than 100 m apart. In this case, a more rigorous multiple source dispersion model such as ISCST3, AERMOD or CALPUFF would be more appropriate.

Volume to Mass Conversion Many gas process calculations and measurements are undertaken on a volumetric basis (e.g., m^3/d, m^3/s). To be meaningful, a volumetric flow rate has to be referenced to a temperature and a pressure. The normal temperature and pressure (NTP) reference values used by the oil and gas industry are 15 °C (288.15 K) and 101.325 kPa (1 atmosphere). This compares to the standard temperature and pressure (STP) of 0 °C (273.15 K) and 101.325 kPa.

By knowing the inlet oil flow rate (*X*), the gas-to-oil ratio (*Y*) and the fraction of H_2S in the solution gas (*Z*); the inlet H_2S, expressed on a volumetric basis (*W*), is:

$$\left[\frac{W\ \mathrm{m^3H_2S}}{\mathrm{s}}\right]=\left[\frac{X\ \mathrm{m^3oil}}{\mathrm{d}}\right]\left[\frac{Y\ \mathrm{m^3gas}}{\mathrm{m^3oil}}\right]\left[\frac{Z\ \mathrm{m^3H_2S}}{\mathrm{m^3gas}}\right]\left[\frac{\mathrm{d}}{24\ \mathrm{h}}\right]\left[\frac{\mathrm{h}}{3600\ \mathrm{s}}\right]$$

The corresponding H_2S mass flow rate can be calculated from knowing the molar mass (34.082 kg/kmole) and the molar volume (22.414 m^3/kmole at STP) for H_2S:

$$\mathrm{H_2S\ (g/s)}=\left[\frac{W\ \mathrm{m^3H_2S}}{\mathrm{s}}\right]\left[\frac{34.082\ \mathrm{kg}}{\mathrm{kmole}}\right]\left[\frac{\mathrm{kmole}}{22.414\ \mathrm{m^3H_2S}}\right]\left[\frac{1000\ \mathrm{g}}{\mathrm{kg}}\right]\left[\frac{273.15\ \mathrm{K}}{288.15\ \mathrm{K}}\right]$$

The temperature ratio converts the molar volume of 22.414 m^3/kmole at 0°C to 15 °C. Because 1 kmole of H_2S produces 1 kmole of SO_2, the corresponding SO2 emission rate is:

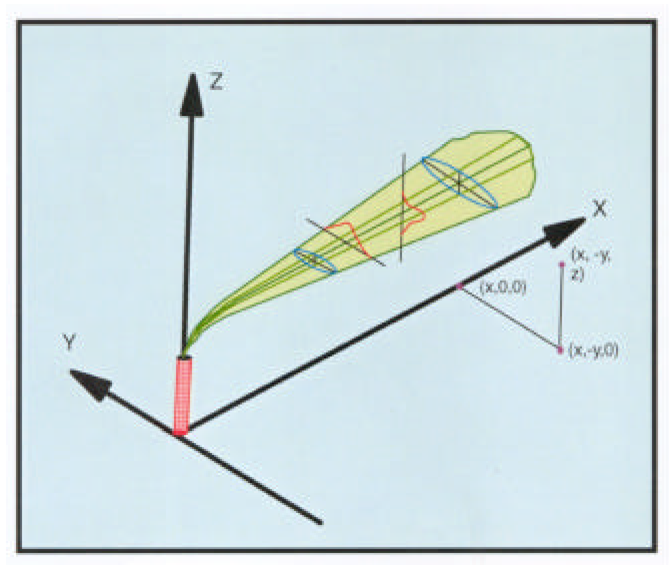
$$\mathrm{SO_2\ (g/s)}=\left[\frac{W\ \mathrm{m^3H_2S}}{\mathrm{s}}\right]\left[\frac{64.065\ \mathrm{kg}}{\mathrm{kmole}}\right]\left[\frac{\mathrm{kmole}}{22.414\ \mathrm{m^3H_2S}}\right]\left[\frac{1000\ \mathrm{g}}{\mathrm{kg}}\right]\left[\frac{273.15\ \mathrm{K}}{288.15\ \mathrm{K}}\right]$$

where 64.065 kg/kmole is the molar mass for SO_2.

4 METEOROLOGY

Meteorology Background

SCREEN3 is based on a Gaussian plume dispersion model as depicted in the following figure:



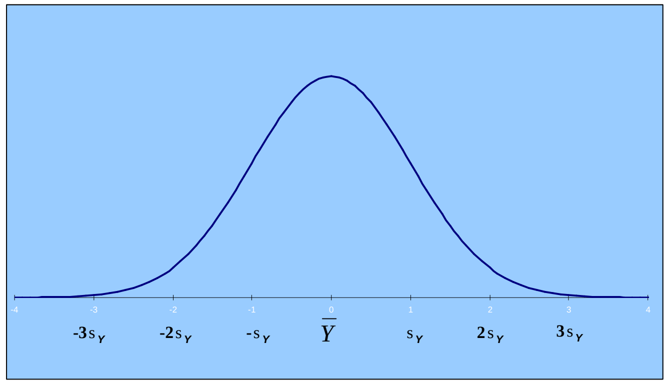
Features of this model are as follows:

- The wind direction is assumed to be uniform in space and time. The location of the plume centreline is determined by a single wind direction, convention has the wind along the x-axis. The maximum ground-level concentration occurs directly below the plume centreline (or y = 0 m).

- The model considers a wide range of wind speeds from 1 to 20 m/s (3.6 to 72 km/h). In order to calculate plume rise and along wind dilution, winds are assumed to increase with increasing height above the ground.

- The crosswind concentration profile is assumed to be symmetrical about the centreline and follow a “Gaussian” or “Normal” distribution. The standard deviation (σ) is a measure of the spread of this distribution. The associated crosswind plume spread is referred to as σ_Y or “sigma-Y”.

- The vertical concentration profile is also assumed to be symmetrical about the centreline and follow a Gaussian distribution. The standard deviation of the vertical spread is referred to as σ_Z or “sigma-Z”.



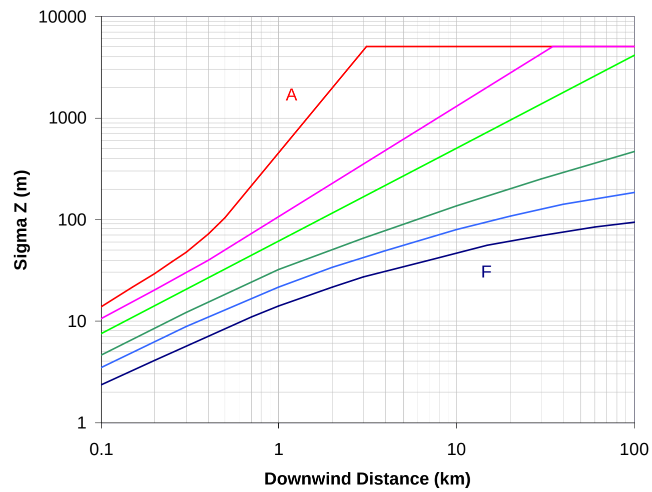
- The plume spreads (σ_y and $\sigma_{Z)}$ can be enhanced or suppressed by increased or decreased levels of atmospheric turbulence, respectively. Mechanical and thermal processes can generate turbulence. Mechanical turbulence is related to wind speed. Thermal turbulence is related to solar intensity.

- For the purpose of dispersion modeling, meteorologists have defined six levels of atmospheric turbulence, referred to as Pasquill-Gifford (PG) stability classes:
  – PG classes A, B and C (sometimes referred to as PG classes 1, 2 and 3) are associated with enhanced turbulence caused by daytime heating and are referred to as <u>unstable</u> conditions.
  – PG class D (sometimes referred to as PG class 4) is associated with mechanically generated turbulence (i.e. high wind speeds) or overcast conditions (i.e., no heating or cooling). This is referred to as <u>neutral</u> conditions.
  – PG classes E and F (sometimes referred to as PG classes 5 and 6) are associated with suppressed turbulence caused by nighttime cooling and are referred to as <u>stable</u> conditions.

Based on an Environment Canada analysis of meteorological data from Estevan Airport (Saskatchewan), PG classes occur with the following frequencies on an annual basis:

Stability	**Unstable**			**Neutral**	**Stable**	
Class	A	B	C	D	E	F
%	0.3	4.3	9.3	59.4	14.8	11.9
%	13.9			59.4	26.7	

Large σ_Y and σ_Z values are associated with unstable conditions and small σ_Y and σ_Z values are associated with stable conditions. Values of σ_Y and σ_Z increase with increasing downwind distance as follows:



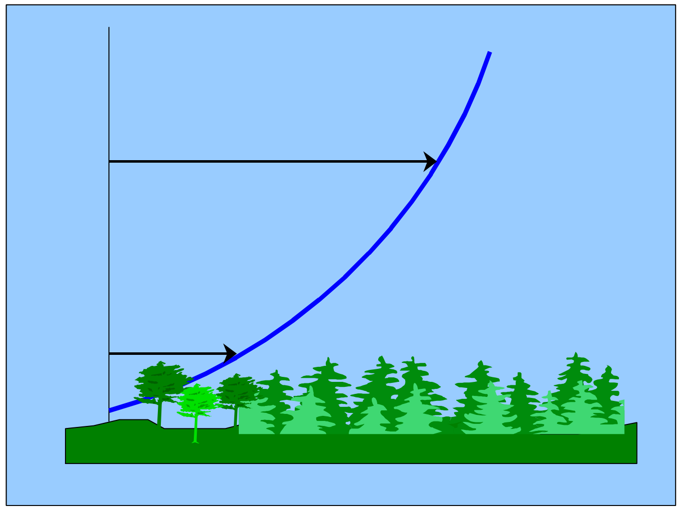
The relationships depicted in the above figures are incorporated into the SCREEN3 Dispersion Model.

Wind Direction

The SCREEN3 model calculates maximum concentrations directly below the plume centreline. Specifically, the location where the concentrations are calculated are assumed to be directly downwind of the emission source. On this basis, the SCREEN3 model does not require wind direction information.

Wind Speed and Stability Class

The wind speeds that are normally measured at height of 10 m are adjusted to plume height by SCREEN3 using a wind profile power law.



Below 10 m, the winds speeds are assumed to be equal to the 10 m level value.

The SCREEN3 model considers the range of wind speed, PG stability class concentrations depicted in the following matrix:

PG Class	10-m Wind Speed (m/s)												
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	8.0	10.0	15.0	20.0
A	✓	✓	✓	✓	✓								
B	✓	✓	✓	✓	✓	✓	✓	✓	✓				
C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
E	✓	✓	✓	✓	✓	✓	✓	✓	✓				
F	✓	✓	✓	✓	✓	✓	✓						

The user for has three options related to the wind speed PG class matrix given in the table:

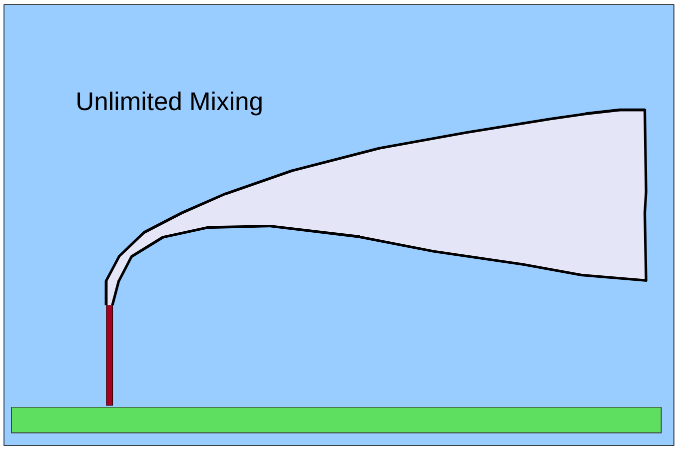
- The Full Meteorology option considers all the meteorological combinations depicted in the matrix for each downwind distance. SCREEN3 only prints out the maximum concentration and associated conditions for each distance.
- The Single Stability Class option considers the range of wind speeds for the specified stability class (i.e., one of A through F). SCREEN3 only prints out the maximum concentration and associated conditions for each distance.

- The Single Stability Class and Wind Speed option considers one specified stability class and wind speed combination. The wind speed for each stability class has to be within the respective range indicated in the matrix.

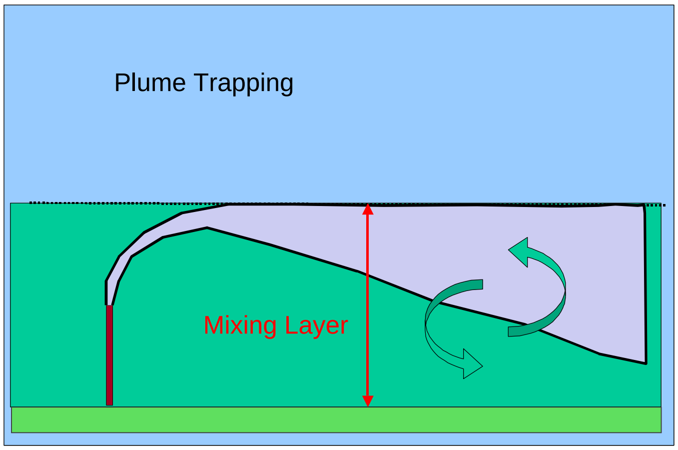
Generally, the Full Meteorology option should be selected. The other two options may be used if specific meteorology conditions are of interest.

Mixing Height

For unlimited mixing, atmospheric turbulence causes the plume to spread above and below the plume centreline:



A limited mixing layer can be generated by thermal turbulence, which is determined by solar intensity or by mechanical turbulence, which is proportional to wind speed. A temperature inversion above the limited mixing layer prevents the vertical plume spread above this mixing layer, producing larger ambient concentrations:



The SCREEN3 model assumes the following:

- Only mechanical mixing heights are assumed
- The mechanical mixing height (m) is assumed to be 320 times the wind speed (m/s).
- If the mechanical mixing height is less than the plume height, the mixing height is taken as the plume height plus 1m.
- Unlimited mixing is assumed for stable conditions.

The SCREEN3 user has no control for the selection of the mixing height.

Fumigation

Fumigation is a general term to describe the rapid mixing of an elevated concentrated plume on the ground. Two fumigation options can occur:

- <u>Inversion Break-Up Fumigation</u>. A ground-based inversion is assumed to occur prior to sunrise with the plume dispersing in the stable layer. After sunrise, a well-mixed layer increases in thickness. When this mixed layer reaches the plume, the plume is rapidly mixed to the ground resulting in relatively high, short-term concentrations.

- <u>Shoreline Fumigation</u>. Stable on-shore airflow can be associated with large water bodies. The stable airflow is modified as it is transported over the land producing a well-mixed boundary layer. When a stable plume intersects the well-mixed layer, it can be rapidly mixed to the ground resulting in relatively high, short-term concentrations.

The SCREEN3 model will only consider fumigation for Point and Flare sources when the stack heights are greater then 10 m and Rural dispersion is assumed.

No user-specified inputs are required for the Inversion Breakup Fumigation option. The Shoreline Fumigation option should be selected if the emission source is within 3 km of a large water body. The user is required to provide the minimum distance between the source and the water body.

Rural and Urban Dispersion

Dispersion over urban areas will differ from that over rural areas for the following reasons:

- The increased roughness and mechanically generated turbulence associated with urban areas will moderate extreme stability conditions.

- The heat capacity of the urban facilities (e.g., buildings and roadways) will moderate the extreme heating and cooling compared to adjacent rural areas.

Due to the above-indicated effects, dispersion associated with Stability classes A and F will not occur in urban areas.

The SCREEN3 user will be required to select either Rural or Urban dispersion. The appropriate classification will depend on the land use within 3 km of the source as follows:

- If industrial, commercial or residential land use exceeds 50%, use the Urban dispersion option.
- If population density is greater than 750 people/km^2, use the Urban dispersion option.

In selecting the dispersion option, priority should be given to the land use description rather than the population. The Urban dispersion option should be used for forest areas due to the increased roughness.

Ambient Temperature

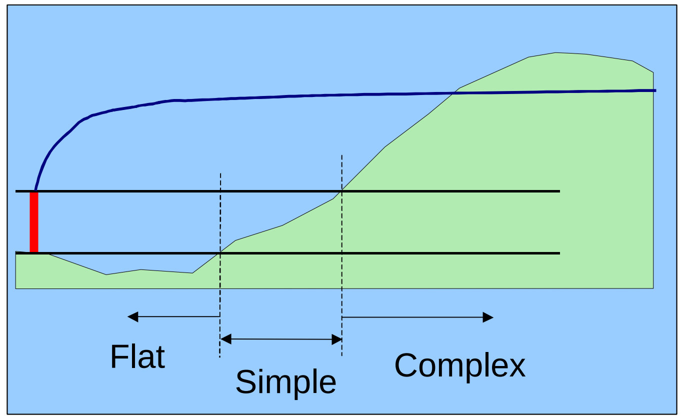
The rise of a hot buoyant plume is proportional to the difference between the stack exit temperature and the ambient air temperature. The smaller the difference (i.e., as would occur during the summer), the smaller the plume rise and the more conservative the predicted concentrations. When using SCREEN3, the following temperatures should be selected:

- Use 288 K for all flare stack calculations due to the manner the plume rise is calculated.
- Use the default temperature of 293 K for all other sources when using the Full Meteorology option.
- Use the temperature representative of the specific meteorological conditions when using the Single Stability Class option or the Single Stability Class and Wind Speed option.

5 RECEPTORS AND TERRAIN

Terrain Types

The model considers the potential for terrain to increase the ambient concentrations by considering a modified plume trajectory that forces the plume to approach, and in the extreme impinge on the terrain feature. The SCREEN3 model considers three terrain types:



- The Flat terrain option assumes that the airflow is parallel to the terrain for all sources.
- The Simple terrain option is for terrain heights that are greater than the stack base and are less than stack height. Not available for Area sources.
- The Complex terrain option is for terrain that exceeds the stack height. For Point and Flare sources only.

Flat Terrain

Flat terrain or parallel airflow can generally be assumed for areas that are flat, or for areas with a gentle slope (e.g., less than 5% or 50 m rise/1000 m distance) and no abrupt terrain features. Flat terrain is selected when the user responds to the "Simple terrain above stack base" input prompt with "No".

For flat terrain, the user can specify an Automated distance array by specifying minimum and maximum distances. The following distances are considered with the array:

- 100 m increments between 100 and 3000 m (30 distances).
- 500 m increments between 3 and 10 km (14 distances).
- 5 km increments between 10 and 30 km (4 distances).
- 10 km increments between 30 and 50 km (2 distances).

The model will also iterate to determine the maximum value to the nearest meter. The minimum distance should correspond to plant fence line. The largest value allowed is 50 km.

The Discrete receptor option corresponding to specific residences or to provide a better resolution near the source can be selected. For example, this option can be used to determine the concentration at a residence located 3200 m downwind, or to determine the concentrations from 10 to 200 m in 10 m increments.

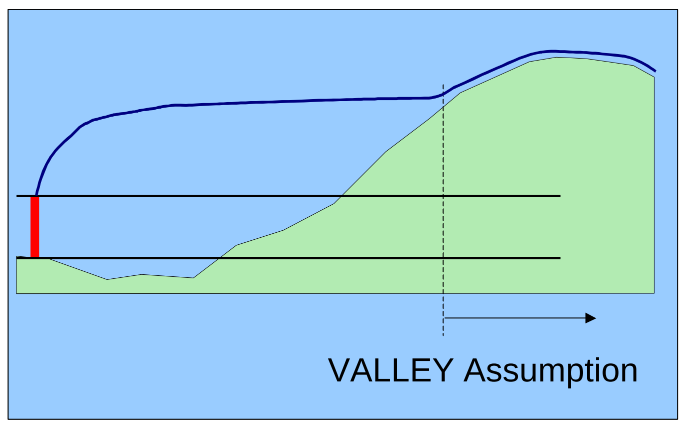
Simple Terrain

For the Simple receptor option, the height of the plume above the ground is decreased by the height of the terrain. This has the effect of bringing the plume closer to the ground and increasing the predicted concentrations relative to the flat terrain assumption.

Complex Terrain

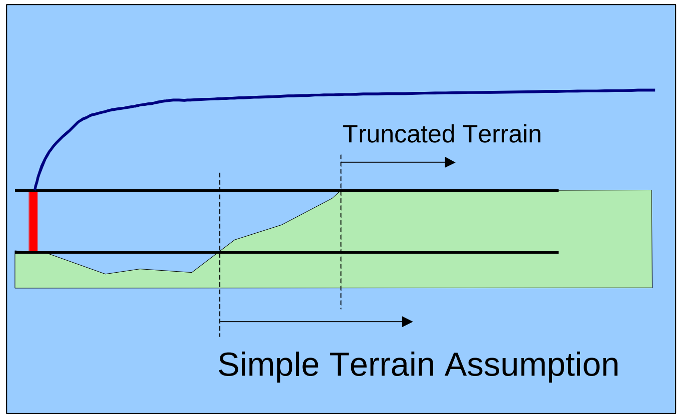
For Complex receptor option, the model predicts maximum 24-h average concentrations using two methods:

- The US EPA **VALLEY model** approach assumes stability class F conditions with a wind speed of 2.5 m/s:



The associated 1-h concentration can be obtained by multiplying the VALLEY 24-h prediction by a factor of 4.

- A **Simple terrain** approach that assumes the terrain is truncated or chopped off at the physical stack height and full meteorology conditions:



The associated 1-h concentration can be obtained by multiplying the simple terrain, 24-h prediction by a factor of 2.5.

The complex terrain prediction is taken as the maximum of these two methods. The appropriate multiplier must be applied to compare to the 1-h ambient criteria. The user does not have any control over the meteorology option for complex terrain.

The model user is required to provide the terrain elevation above stack base and the associated downwind distance for as many downwind distance combinations as required.

6 OUTPUT INTERPRETATION

Averaging Period

The US EPA dispersion coefficients incorporated into the SCREEN3 model are assumed by the US EPA to represent one-hour average concentrations. This allows the dispersion model predictions to be compared directly to the one-hour average maximum ambient concentration criteria.

For Complex terrain, the model predicts 24-hour averages. These can be adjusted to a 1-hour average using the adjustment factors given in the previous section.

Averaging Periods Longer than One Hour

The maximum predicted one-hour average concentrations can be used to estimate maximum concentrations for longer averaging periods. The SCREEN guide recommends the following "general case" multiplication conversion factors:

Averaging Period	Multiplication Factor
1-h	1.0
3-h	0.9 ± 0.1
8-h	0.7 ± 0.2
24-h	0.4 ± 0.2
Annual	0.08 ± 0.02

While the values provided are intended as a rough guide, the smaller factors (within the range) are more applicable to tall stacks and/or flat terrain and the larger factors (within the range) are more applicable to short stacks and/or complex terrain locations.

Peak-To-Mean Ratio

The models are designed to predict one-hour average concentrations. Over the one-hour period, concentrations can vary considerably, sometimes being less than the mean and other times exceeding the mean. Short-term (i.e., 5 minutes) concentrations in excess of an odour threshold may occur when the one-hour average is within an acceptable range.

For this reason, an understanding of peak concentrations may be of interest when dealing with pollutants that have an odour potential (i.e., H_2S). A peak-to-mean ratio concept has been adopted to address this situation. As a rough guide a peak-to-mean value of 5 is recommended.

7 REGULATORY SUBMISSION

Submission Requirements

The clear communication of information between industry and regulatory staff will help expedite the review and approval process. From an air quality perspective, the following information will help the process:

(1) Identification and Contact Information.

Name and address of applicant.
Contact person, telephone number and e-mail address.
Battery Name and Permit No. (existing batteries).
Type of application: New, Amendment

(2) Facility Information

Description of application request.
Facility plot plan identifying emission sources.
Inlet oil flow rate.
Inlet gas to oil ratio.
Composition of solution gas.

(3) Emission Information

For a flare stack:

Stack height
Stack diameter
Volume of gas to flare
Heat content of gas to flare
SO_2 emission rate

For a heater-treater stack:

Stack height
Stack diameter
Stack gas exit velocity
Stack gas exit temperature
SO_2 emission rate
Building/Structure height (if applicable)
Building/Structure length (if applicable)
Building/Structure width (if applicable)

For a heater-treater upset event:

If a significant volume of gas will be vented in the event of a treater upset, the operator should model these emissions. In his case, the following are required:
Stack height
Stack diameter

Stack gas exit velocity
Stack gas exit temperature
H_2S emission rate
Building/Structure height (if applicable)
Building/Structure length (if applicable)
Building/Structure width (if applicable)

For a tank vent:

Tank product
Vent height
Vent diameter
Vent gas exit velocity
Vent gas exit temperature
H_2S emission rate
Tank height
Tank diameter

Description of the facility air pollution control practises. Rational for the selection or absence of pollution control practices (i.e., vapour recovery).

(4) Ambient Predictions

Maximum predicted H_2S and SO_2 concentrations associated with the facility. Description of modelling assumptions and supporting spreadsheet and SCREEN3 model output.

Does facility meet ambient concentration criteria? If not, where are exceedances expected? What control actions and what timeline will be applied to be in compliance?

Identification of public information program.

8 EXAMPLES

Input Cases:

The following **HEATER-TREATER** examples are provided:

Case	**Case 1**	**Case 2**	**Case 3**	**Case 4**
Stack height (m)	6.1	6.1	6.1	6.1
Stack diameter (m)	0.30	0.30	0.30	0.30
Stack gas exit velocity (m/s)	2.5	2.5	2.5	2.5
Stack gas exit temperature (K)	573	573	573	573
SO_2 emission rate (g/s)	0.5	0.5	0.5	0.5
Building/Structure height (m)	0.0	0.0	0.0	**4.0**
Building/Structure length (m)	0.0	0.0	0.0	**3.0**
Building/Structure width (m)	0.0	0.0	0.0	**6.0**
Meteorology	Full	Full	Full	Full
Ambient Temperature (K)	293	293	293	293
Dispersion	Rural	**Urban**	Rural	Rural
Minimum/Maximum Distances (m)	100 50000	100 50000	**10** **200**	100 50000
Terrain	Flat	Flat	Flat	Flat
Input values that have changed from the Base Case (Case 1) are shown in boldface text.				

Interpretation:

Case	**Case 1**	**Case 2**	**Case 3**	**Case 4**
Maximum SO_2 ($\mu g/m^3$)	357.7	**431.3**	**359.3**	**515.0**
Downwind distance (m)	100	100	**110**	100
PG Stability Class	C (3)	**D (4)**	C (3)	**D (4)**
10-m Wind Speed (m/s)	1.5	**1.0**	1.5	**2.0**
Mixing Height (m)	480	**320**	480	**640**
Building Cavity SO_2 ($\mu g/m^3$)	-	-	-	**11710**
Distance to Cavity Maximum (m)	-	-	-	**10**
Input values that have changed from the Base Case (Case 1) are shown in boldface text.				

```
                                                                        02/03/02
                                                                        20:03:49
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Heater-treater Stack SO2   Case 1

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HEIGHT (M)       =       6.1000
   STK INSIDE DIAM (M)    =        .3000
   STK EXIT VELOCITY (M/S)=       2.5000
   STK GAS EXIT TEMP (K)  =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =     .270 M**4/S**3;  MOM. FLUX =     .072 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)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
100.	357.7	3	1.5	1.5	480.0	11.44	12.56	7.60	NO
200.	326.5	4	1.5	1.5	480.0	11.44	15.64	8.64	NO
300.	294.8	4	1.0	1.0	320.0	14.11	22.73	12.31	NO
400.	229.7	4	1.0	1.0	320.0	14.11	29.54	15.44	NO
500.	177.8	4	1.0	1.0	320.0	14.11	36.22	18.44	NO
600.	140.1	4	1.0	1.0	320.0	14.11	42.78	21.33	NO
700.	112.8	4	1.0	1.0	320.0	14.11	49.24	24.14	NO
800.	101.1	6	1.0	1.0	10000.0	22.03	28.01	12.81	NO
900.	103.1	6	1.0	1.0	10000.0	22.03	31.11	13.76	NO
1000.	102.8	6	1.0	1.0	10000.0	22.03	34.19	14.68	NO
1100.	100.4	6	1.0	1.0	10000.0	22.03	37.24	15.50	NO
1200.	97.28	6	1.0	1.0	10000.0	22.03	40.27	16.31	NO
1300.	93.72	6	1.0	1.0	10000.0	22.03	43.28	17.09	NO
1400.	89.96	6	1.0	1.0	10000.0	22.03	46.27	17.85	NO
1500.	86.15	6	1.0	1.0	10000.0	22.03	49.24	18.60	NO
1600.	82.38	6	1.0	1.0	10000.0	22.03	52.19	19.33	NO
1700.	78.72	6	1.0	1.0	10000.0	22.03	55.13	20.04	NO
1800.	75.19	6	1.0	1.0	10000.0	22.03	58.05	20.74	NO
1900.	71.83	6	1.0	1.0	10000.0	22.03	60.95	21.43	NO
2000.	68.63	6	1.0	1.0	10000.0	22.03	63.84	22.10	NO
2100.	65.62	6	1.0	1.0	10000.0	22.03	66.71	22.67	NO
2200.	62.80	6	1.0	1.0	10000.0	22.03	69.57	23.23	NO
2300.	60.16	6	1.0	1.0	10000.0	22.03	72.42	23.78	NO
2400.	57.69	6	1.0	1.0	10000.0	22.03	75.26	24.32	NO
2500.	55.37	6	1.0	1.0	10000.0	22.03	78.08	24.85	NO
2600.	53.19	6	1.0	1.0	10000.0	22.03	80.89	25.36	NO
2700.	51.15	6	1.0	1.0	10000.0	22.03	83.69	25.87	NO
2800.	49.22	6	1.0	1.0	10000.0	22.03	86.48	26.38	NO
2900.	47.41	6	1.0	1.0	10000.0	22.03	89.27	26.87	NO
3000.	45.70	6	1.0	1.0	10000.0	22.03	92.04	27.36	NO
3500.	38.70	6	1.0	1.0	10000.0	22.03	105.75	29.34	NO
4000.	33.35	6	1.0	1.0	10000.0	22.03	119.26	31.17	NO
4500.	29.16	6	1.0	1.0	10000.0	22.03	132.58	32.89	NO

```
  5000.   25.81        6     1.0    1.0 10000.0   22.03  145.74   34.51    NO
  5500.   23.07        6     1.0    1.0 10000.0   22.03  158.76   36.05    NO
  6000.   20.80        6     1.0    1.0 10000.0   22.03  171.64   37.51    NO
  6500.   18.90        6     1.0    1.0 10000.0   22.03  184.40   38.91    NO
  7000.   17.27        6     1.0    1.0 10000.0   22.03  197.05   40.26    NO
  7500.   15.92        6     1.0    1.0 10000.0   22.03  209.59   41.41    NO
  8000.   14.74        6     1.0    1.0 10000.0   22.03  222.03   42.53    NO
  8500.   13.71        6     1.0    1.0 10000.0   22.03  234.38   43.60    NO
  9000.   12.80        6     1.0    1.0 10000.0   22.03  246.65   44.63    NO
  9500.   11.99        6     1.0    1.0 10000.0   22.03  258.83   45.63    NO
 10000.   11.27        6     1.0    1.0 10000.0   22.03  270.94   46.61    NO
 15000.   6.867        6     1.0    1.0 10000.0   22.03  388.45   55.07    NO
 20000.   4.917        6     1.0    1.0 10000.0   22.03  500.97   60.47    NO
 25000.   3.791        6     1.0    1.0 10000.0   22.03  609.77   65.02    NO
 30000.   3.064        6     1.0    1.0 10000.0   22.03  715.60   68.99    NO
 40000.   2.219        6     1.0    1.0 10000.0   22.03  920.23   74.63    NO
 50000.   1.728        6     1.0    1.0 10000.0   22.03 1117.43   79.32    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   100.   357.7        3     1.5    1.5   480.0   11.44   12.56    7.60    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        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------   -----------   -------   -------
SIMPLE TERRAIN      357.7          100.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
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02/03/02
20:04:44

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

Heater-treater Stack SO2   Case 2

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HEIGHT (M)       =       6.1000
   STK INSIDE DIAM (M)    =        .3000
   STK EXIT VELOCITY (M/S)=       2.5000
   STK GAS EXIT TEMP (K)  =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        URBAN
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =     .270 M**4/S**3;  MOM. FLUX =     .072 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)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
100.	431.3	4	1.0	1.0	320.0	14.11	15.86	13.98	NO
200.	165.2	4	1.0	1.0	320.0	14.11	30.88	27.29	NO
300.	138.2	6	1.0	1.0	10000.0	22.03	31.51	20.44	NO
400.	104.3	6	1.0	1.0	10000.0	22.03	41.11	25.70	NO
500.	79.64	6	1.0	1.0	10000.0	22.03	50.41	30.58	NO
600.	62.62	6	1.0	1.0	10000.0	22.03	59.44	35.12	NO
700.	50.67	6	1.0	1.0	10000.0	22.03	68.21	39.38	NO
800.	42.02	6	1.0	1.0	10000.0	22.03	76.73	43.39	NO
900.	35.58	6	1.0	1.0	10000.0	22.03	85.01	47.19	NO
1000.	30.64	6	1.0	1.0	10000.0	22.03	93.08	50.80	NO
1100.	26.76	6	1.0	1.0	10000.0	22.03	100.94	54.25	NO
1200.	23.67	6	1.0	1.0	10000.0	22.03	108.60	57.55	NO
1300.	21.14	6	1.0	1.0	10000.0	22.03	116.08	60.72	NO
1400.	19.05	6	1.0	1.0	10000.0	22.03	123.38	63.77	NO
1500.	17.31	6	1.0	1.0	10000.0	22.03	130.52	66.72	NO
1600.	15.82	6	1.0	1.0	10000.0	22.03	137.51	69.57	NO
1700.	14.55	6	1.0	1.0	10000.0	22.03	144.35	72.32	NO
1800.	13.46	6	1.0	1.0	10000.0	22.03	151.04	75.00	NO
1900.	12.50	6	1.0	1.0	10000.0	22.03	157.61	77.60	NO
2000.	11.66	6	1.0	1.0	10000.0	22.03	164.04	80.13	NO
2100.	10.92	6	1.0	1.0	10000.0	22.03	170.36	82.59	NO
2200.	10.26	6	1.0	1.0	10000.0	22.03	176.56	85.00	NO
2300.	9.664	6	1.0	1.0	10000.0	22.03	182.64	87.34	NO
2400.	9.133	6	1.0	1.0	10000.0	22.03	188.63	89.64	NO
2500.	8.653	6	1.0	1.0	10000.0	22.03	194.51	91.88	NO
2600.	8.218	6	1.0	1.0	10000.0	22.03	200.29	94.08	NO
2700.	7.822	6	1.0	1.0	10000.0	22.03	205.98	96.23	NO
2800.	7.460	6	1.0	1.0	10000.0	22.03	211.58	98.34	NO
2900.	7.128	6	1.0	1.0	10000.0	22.03	217.10	100.41	NO
3000.	6.822	6	1.0	1.0	10000.0	22.03	222.53	102.44	NO
3500.	5.603	6	1.0	1.0	10000.0	22.03	248.56	112.09	NO
4000.	4.739	6	1.0	1.0	10000.0	22.03	272.91	121.03	NO
4500.	4.098	6	1.0	1.0	10000.0	22.03	295.85	129.40	NO

```
  5000.   3.604        6     1.0    1.0 10000.0   22.03  317.58  137.27    NO
  5500.   3.213        6     1.0    1.0 10000.0   22.03  338.24  144.74    NO
  6000.   2.897        6     1.0    1.0 10000.0   22.03  357.96  151.86    NO
  6500.   2.636        6     1.0    1.0 10000.0   22.03  376.87  158.66    NO
  7000.   2.417        6     1.0    1.0 10000.0   22.03  395.03  165.20    NO
  7500.   2.231        6     1.0    1.0 10000.0   22.03  412.53  171.49    NO
  8000.   2.071        6     1.0    1.0 10000.0   22.03  429.42  177.56    NO
  8500.   1.932        6     1.0    1.0 10000.0   22.03  445.77  183.44    NO
  9000.   1.811        6     1.0    1.0 10000.0   22.03  461.61  189.14    NO
  9500.   1.703        6     1.0    1.0 10000.0   22.03  477.00  194.67    NO
 10000.   1.607        6     1.0    1.0 10000.0   22.03  491.96  200.05    NO
 15000.   1.027        6     1.0    1.0 10000.0   22.03  623.66  247.58    NO
 20000.   .7529        6     1.0    1.0 10000.0   22.03  733.35  287.40    NO
 25000.   .5940        6     1.0    1.0 10000.0   22.03  829.17  322.36    NO
 30000.   .4904        6     1.0    1.0 10000.0   22.03  915.27  353.89    NO
 40000.   .4016        4     1.0    1.0   320.0   14.11 1552.23 1553.16    NO
 50000.   .3571        4     1.0    1.0   320.0   14.11 1745.74 1750.00    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   100.   431.3        4     1.0    1.0   320.0   14.11   15.86   13.98    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       MAX CONC    DIST TO   TERRAIN
  PROCEDURE       (UG/M**3)    MAX (M)    HT (M)
--------------    -----------  -------   -------
SIMPLE TERRAIN      431.3         100.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
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02/03/02
20:06:21

```
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Heater-treater Stack SO2   Case 3

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HEIGHT (M)       =       6.1000
   STK INSIDE DIAM (M)    =        .3000
   STK EXIT VELOCITY (M/S)=       2.5000
   STK GAS EXIT TEMP (K)  =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =     .270 M**4/S**3;  MOM. FLUX =     .072 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN DISCRETE DISTANCES ***
**********************************

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

  DIST     CONC           U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
    10.   .2393E-01    1     3.0    3.0   960.0    8.37    3.39    1.65    NO
    20.   75.45        1     3.0    3.0   960.0    8.37    6.33    3.13    NO
    30.   233.9        1     3.0    3.0   960.0    8.37    9.11    4.54    NO
    40.   287.6        1     2.5    2.5   800.0    9.01   11.81    5.94    NO
    50.   306.4        2     2.5    2.5   800.0    9.01   10.28    5.63    NO
    60.   323.3        2     2.0    2.0   640.0    9.96   12.14    6.69    NO
    70.   330.9        3     2.5    2.5   800.0    9.01    9.01    5.45    NO
    80.   347.2        3     2.5    2.5   800.0    9.01   10.18    6.14    NO
    90.   355.7        3     2.0    2.0   640.0    9.96   11.36    6.85    NO
   100.   357.7        3     1.5    1.5   480.0   11.44   12.56    7.60    NO
   110.   359.3        3     1.5    1.5   480.0   11.44   13.70    8.26    NO
   120.   352.4        3     1.5    1.5   480.0   11.44   14.83    8.92    NO
   130.   356.1        3     1.0    1.0   320.0   14.11   16.04    9.73    NO
   140.   354.5        3     1.0    1.0   320.0   14.11   17.16   10.38    NO
   150.   348.2        3     1.0    1.0   320.0   14.11   18.26   11.02    NO
   160.   338.8        3     1.0    1.0   320.0   14.11   19.37   11.67    NO
   170.   329.7        4     1.5    1.5   480.0   11.44   13.48    7.54    NO
   180.   331.4        4     1.5    1.5   480.0   11.44   14.20    7.90    NO
   190.   330.1        4     1.5    1.5   480.0   11.44   14.92    8.27    NO
   200.   326.5        4     1.5    1.5   480.0   11.44   15.64    8.64    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        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
```

```
--------------    -----------   -------   -------
SIMPLE TERRAIN      359.3          110.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
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                                                                02/03/02
                                                                20:19:49
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Heater-treater Stack SO2   Case 4

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HEIGHT (M)       =       6.1000
   STK INSIDE DIAM (M)    =        .3000
   STK EXIT VELOCITY (M/S)=       2.5000
   STK GAS EXIT TEMP (K)  =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =       4.0000
   MIN HORIZ BLDG DIM (M) =       3.0000
   MAX HORIZ BLDG DIM (M) =       6.0000

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


BUOY. FLUX =     .270 M**4/S**3;  MOM. FLUX =     .072 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
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   100.   515.0        4     2.0    2.0   640.0    9.96    8.28    7.23    HS
   200.   404.9        4     1.0    1.0   320.0   14.11   15.73   11.05    HS
   300.   300.9        4     1.0    1.0   320.0   14.11   22.73   14.08    HS
   400.   224.0        4     1.0    1.0   320.0   14.11   29.54   17.13    HS
   500.   171.0        4     1.0    1.0   320.0   14.11   36.22   20.07    HS
   600.   134.3        4     1.0    1.0   320.0   14.11   42.78   22.92    HS
   700.   124.8        6     1.0    1.0 10000.0   22.03   24.88   13.48    HS
   800.   122.5        6     1.0    1.0 10000.0   22.03   28.01   14.41    HS
   900.   116.4        6     1.0    1.0 10000.0   22.03   31.11   15.05    HS
  1000.   111.9        6     1.0    1.0 10000.0   22.03   34.19   15.87    HS
  1100.   107.0        6     1.0    1.0 10000.0   22.03   37.24   16.66    HS
  1200.   102.0        6     1.0    1.0 10000.0   22.03   40.27   17.43    HS
  1300.   97.07        6     1.0    1.0 10000.0   22.03   43.28   18.19    HS
  1400.   92.29        6     1.0    1.0 10000.0   22.03   46.27   18.93    HS
  1500.   87.72        6     1.0    1.0 10000.0   22.03   49.24   19.65    HS
  1600.   83.39        6     1.0    1.0 10000.0   22.03   52.19   20.36    HS
  1700.   79.31        6     1.0    1.0 10000.0   22.03   55.13   21.05    HS
  1800.   75.47        6     1.0    1.0 10000.0   22.03   58.05   21.73    HS
  1900.   71.89        6     1.0    1.0 10000.0   22.03   60.95   22.01    HS
  2000.   68.59        6     1.0    1.0 10000.0   22.03   63.84   22.59    HS
  2100.   65.52        6     1.0    1.0 10000.0   22.03   66.71   23.16    HS
  2200.   62.65        6     1.0    1.0 10000.0   22.03   69.57   23.70    HS
  2300.   59.98        6     1.0    1.0 10000.0   22.03   72.42   24.24    HS
  2400.   57.48        6     1.0    1.0 10000.0   22.03   75.26   24.77    HS
  2500.   55.14        6     1.0    1.0 10000.0   22.03   78.08   25.29    HS
  2600.   52.96        6     1.0    1.0 10000.0   22.03   80.89   25.81    HS
  2700.   50.90        6     1.0    1.0 10000.0   22.03   83.69   26.31    HS
  2800.   48.97        6     1.0    1.0 10000.0   22.03   86.48   26.80    HS
  2900.   47.16        6     1.0    1.0 10000.0   22.03   89.27   27.29    HS
  3000.   45.62        6     1.0    1.0 10000.0   22.03   92.04   27.49    HS
  3500.   38.62        6     1.0    1.0 10000.0   22.03  105.75   29.46    HS
  4000.   33.29        6     1.0    1.0 10000.0   22.03  119.26   31.29    HS
  4500.   29.11        6     1.0    1.0 10000.0   22.03  132.58   33.00    HS
```

```
  5000.   25.76        6     1.0    1.0 10000.0   22.03  145.74   34.61    HS
  5500.   23.03        6     1.0    1.0 10000.0   22.03  158.76   36.14    HS
  6000.   20.77        6     1.0    1.0 10000.0   22.03  171.64   37.61    HS
  6500.   18.87        6     1.0    1.0 10000.0   22.03  184.40   39.00    HS
  7000.   17.27        6     1.0    1.0 10000.0   22.03  197.05   40.26    HS
  7500.   15.92        6     1.0    1.0 10000.0   22.03  209.59   41.42    HS
  8000.   14.74        6     1.0    1.0 10000.0   22.03  222.03   42.53    HS
  8500.   13.71        6     1.0    1.0 10000.0   22.03  234.38   43.60    HS
  9000.   12.80        6     1.0    1.0 10000.0   22.03  246.65   44.64    HS
  9500.   11.99        6     1.0    1.0 10000.0   22.03  258.83   45.64    HS
 10000.   11.27        6     1.0    1.0 10000.0   22.03  270.94   46.61    HS
 15000.   6.867        6     1.0    1.0 10000.0   22.03  388.45   55.07    HS
 20000.   4.917        6     1.0    1.0 10000.0   22.03  500.97   60.47    HS
 25000.   3.791        6     1.0    1.0 10000.0   22.03  609.77   65.02    HS
 30000.   3.064        6     1.0    1.0 10000.0   22.03  715.60   68.99    HS
 40000.   2.219        6     1.0    1.0 10000.0   22.03  920.23   74.63    HS
 50000.   1.728        6     1.0    1.0 10000.0   22.03 1117.43   79.32    HS

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   100.   515.0        4     2.0    2.0   640.0    9.96    8.28    7.23    HS

 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

****************************************
     *** REGULATORY (Default) ***
    PERFORMING CAVITY CALCULATIONS
  WITH ORIGINAL SCREEN CAVITY MODEL
          (BRODE, 1988)
****************************************


 *** CAVITY CALCULATION - 1 ***       *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)     =    .1171E+05    CONC (UG/M**3)     =    .0000
  CRIT WS @10M (M/S) =     2.37        CRIT WS @10M (M/S) =    99.99
  CRIT WS @ HS (M/S) =     2.37        CRIT WS @ HS (M/S) =    99.99
  DILUTION WS (M/S)  =     1.19        DILUTION WS (M/S)  =    99.99
  CAVITY HT (M)      =     6.41        CAVITY HT (M)      =     4.91
  CAVITY LENGTH (M)  =     9.73        CAVITY LENGTH (M)  =     3.40
  ALONGWIND DIM (M)  =     3.00        ALONGWIND DIM (M)  =     6.00

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

****************************************
      END OF CAVITY CALCULATIONS
****************************************


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

 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      515.0          100.        0.

BLDG. CAVITY-1      .1171E+05       10.       --  (DIST = CAVITY LENGTH)

BLDG. CAVITY-2      .0000            3.       --  (DIST = CAVITY LENGTH)


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

Input Cases:

The following **FLARE STACK** examples are provided:

Case	**Case 1**	**Case 2**	**Case 3**	**Case 4**
Source Type	Point	Point	**Flare**	Point
Stack height (m)	5.0	5.0	5.0	5.0
Stack diameter (m)	0.076	0.076	0.076	0.076
Radiation Loss (%)	25	**55**	55	55
Pseudo height (m)	6.02	6.02	-	6.02
Pseudo Diameter (m)	0.972	**0.753**	-	**0.190**
Heat Release (cal/s)	-	-	**82314**	**-**
Stack gas exit velocity (m/s)	1.28	1.28	-	**20.0**
Stack gas exit temperature (K)	1273	1273	-	1273
SO_2 emission rate (g/s)	0.218	0.218	0.218	0.218
Meteorology	Full	Full	Full	Full
Ambient Temperature (K)	288	288	288	288
Dispersion	Rural	Rural	Rural	Rural
Minimum/Maximum Distances (m)	100 5000	100 5000	100 5000	100 5000
Terrain	Flat	Flat	Flat	Flat
Input values that have changed from the Base Case (Case 1) are shown in boldface text.				

Interpretation:

Case	Case 1	Case 2	Case 3	Case 4
Maximum SO_2 ($\mu g/m^3$)	54	**66**	**48**	**47**
Downwind distance (m)	100	**109**	**112**	**112**
PG Stability Class	4	4	**3**	**3**
10-m Wind Speed (m/s)	15	**8**	**4.5**	**4.5**
Mixing Height (m)	4800	**2560**	**1440**	**1440**
Buoyancy Flux (m^4/s^3)	2.294	**1.377**	**1.365**	**1.370**
Momentum Flux (m^4/s^2)	0.088	**0.053**	**0.832**	**0.817**
Input values that have changed from the Base Case (Case 1) are shown in boldface text.				

Case 1 is modelled as a Point source, assumes 25% radiation and uses an actual exit velocity. The exit velocity is low and hence the plume is subject to stack downwash.

Case 2 is modelled as a Point source, assumes 55% radiation and uses an actual exit velocity. Less energy is available to contribute to the plume rise as indicated by the lower buoyancy and momentum fluxes that determine the plume rise. The lower plume rise produces greater ground level concentrations.

Case 3 is modelled as a Flare source and the SCREEN3 model assumes 55% radiation and an exit velocity of 20 m/s. With this exit velocity, the plume is not subject to stack downwash. The buoyancy flux is virtually identical to Case 2, but the momentum flux (due to the exit velocity) is much larger. For low exit velocities, this representation, which is the default US EPA mode, does not account for downwash that can occur for low exit velocities.

Case 4 is modelled as a Point source to represent Case 3 assumptions. The buoyancy flux, the momentum flux and the ground level concentrations are virtually identical to Case 3 demonstrating the equivalency of the Point and Flare methods.

Sour Gas Flare Properties

Company	ABC oil
Facility	Battery Example
Case	Solution Gas Flaring (25% case)

Flow Rate

Gas Stream	Solution	None	To Flare	
Flow Rate	0.500	0.000	0.500	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)

H_2	0.0000		0.0000	Mole Fraction
He	0.0004		0.0004	
N_2	0.1485		0.1485	
CO_2	0.0693		0.0693	
H_2S	0.0139		0.0139	
C_1	0.1085		0.1085	
C_2	0.2620		0.2620	
C_3	0.2511		0.2511	
iC_4	0.0325		0.0325	
nC_4	0.0710		0.0710	
iC_5	0.0154		0.0154	
nC_5	0.0139		0.0139	
C_6	0.0080		0.0080	
C_7+	0.0055		0.0055	
Total	1.0000	0.0000	1.0000	

Gas Stream Properties

Molecular Mass	37.75	0.00	37.75	kg/kmole
Net Heating Value	59.55	0.00	59.55	10^3 m^3/d at 15°C and 101.3 kPa
Net Heat Release Rate	82,314	0	82,314	cal/s
Equivalent SO_2 Inlet	0.019	0.000	0.019	t/d
Equivalent SO_2 Inlet	0.22	0.00	0.22	g/s

Stack Parameters

Flare Stack Height	5.0	m	
Flare Stack Diameter	76.00	mm	
Actual Exit Velocity	1.28	m/s	
Length of Flame:	1.29	m	
Heat Intensity at Base	1.23	kW/m^2	Background = 1.04 kW/m^2
Conversion Efficiency	100.00	%	
Radiation Loss	25	%	(Brode => 55%, AENV => 25%)
Sensible Heat Release	61,736	cal/s	Based on conversion efficiency & radiation loss

Model Input Parameters

Effective Stack Height	6.02	m	(per EPA and Beychok,M.; 1979)
Pseudo-diameter	**0.972**	**m**	based on actual exit velocity
Actual Exit Velocity	1.28	m/s	
Exit Temperature	1273	K	1000 °C
Ambient temperature	288	K	Pseudo temperature for modelling

Emissions

SO_2 Emission	0.218	g/s	Based on user-specified conversion efficiency
H_2S 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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Version 5 (Compatible with EUB Spreadsheet)

02/07/02
21:21:21

```
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Flare SO2   25%              Case 1

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .218000
   STACK HEIGHT (M)       =       6.0200
   STK INSIDE DIAM (M)    =        .9720
   STK EXIT VELOCITY (M/S)=       1.2800
   STK GAS EXIT TEMP (K)  =    1273.0000
   AMBIENT AIR TEMP (K)   =     288.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =    2.294 M**4/S**3;  MOM. FLUX =     .088 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)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
100.	53.97	4	15.0	15.0	4800.0	5.93	8.24	4.71	NO
200.	42.13	4	5.0	5.0	1600.0	11.59	15.73	8.80	NO
300.	33.33	4	4.0	4.0	1280.0	13.71	22.79	12.42	NO
400.	27.15	4	3.0	3.0	960.0	17.25	29.70	15.74	NO
500.	22.93	4	2.5	2.5	800.0	20.07	36.43	18.86	NO
600.	19.86	4	2.0	2.0	640.0	24.32	43.10	21.97	NO
700.	17.47	4	2.0	2.0	640.0	24.32	49.52	24.70	NO
800.	15.69	4	1.5	1.5	480.0	31.39	56.09	27.84	NO
900.	14.32	4	1.5	1.5	480.0	31.39	62.35	30.43	NO
1000.	13.01	4	1.5	1.5	480.0	31.39	68.55	32.98	NO
1100.	11.84	4	1.5	1.5	480.0	31.39	74.70	34.96	NO
1200.	11.11	6	1.5	1.5	10000.0	33.02	40.82	17.62	NO
1300.	11.40	6	1.5	1.5	10000.0	33.02	43.79	18.34	NO
1400.	11.57	6	1.5	1.5	10000.0	33.02	46.75	19.06	NO
1500.	11.89	6	1.0	1.0	10000.0	37.94	49.89	20.26	NO
1600.	12.15	6	1.0	1.0	10000.0	37.94	52.81	20.93	NO
1700.	12.33	6	1.0	1.0	10000.0	37.94	55.71	21.59	NO
1800.	12.43	6	1.0	1.0	10000.0	37.94	58.60	22.24	NO
1900.	12.48	6	1.0	1.0	10000.0	37.94	61.48	22.89	NO
2000.	12.49	6	1.0	1.0	10000.0	37.94	64.34	23.52	NO
2100.	12.38	6	1.0	1.0	10000.0	37.94	67.20	24.06	NO
2200.	12.25	6	1.0	1.0	10000.0	37.94	70.04	24.58	NO
2300.	12.11	6	1.0	1.0	10000.0	37.94	72.87	25.10	NO
2400.	11.95	6	1.0	1.0	10000.0	37.94	75.69	25.61	NO
2500.	11.79	6	1.0	1.0	10000.0	37.94	78.49	26.11	NO
2600.	11.61	6	1.0	1.0	10000.0	37.94	81.29	26.61	NO
2700.	11.43	6	1.0	1.0	10000.0	37.94	84.08	27.10	NO
2800.	11.25	6	1.0	1.0	10000.0	37.94	86.86	27.58	NO
2900.	11.06	6	1.0	1.0	10000.0	37.94	89.63	28.05	NO
3000.	10.87	6	1.0	1.0	10000.0	37.94	92.39	28.51	NO
3500.	9.883	6	1.0	1.0	10000.0	37.94	106.06	30.42	NO
4000.	9.006	6	1.0	1.0	10000.0	37.94	119.53	32.19	NO
4500.	8.237	6	1.0	1.0	10000.0	37.94	132.82	33.86	NO

```
  5000.   7.564        6     1.0    1.0 10000.0   37.94  145.96   35.43    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   100.   53.97        4    15.0   15.0  4800.0    5.93    8.24    4.71    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        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      53.97          100.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

RWDI

Sour Gas Flare Properties

Company ABC oil
Facility Battery Example
Case Solution Gas Flaring (55% case)

Flow Rate

Gas Stream	Solution	None	To Flare	
Flow Rate	0.500	0.000	0.500	10^3 m³/d at 15°C and 101.3 kPa
Percentage	100.0	0.0	100.0	%
Reference Temp	15	15	15	°C

Composition (dry)

H_2	0.0000		0.0000	Mole Fraction
He	0.0004		0.0004	
N_2	0.1485		0.1485	
CO_2	0.0693		0.0693	
H_2S	0.0139		0.0139	
C_1	0.1085		0.1085	
C_2	0.2620		0.2620	
C_3	0.2511		0.2511	
iC_4	0.0325		0.0325	
nC_4	0.0710		0.0710	
iC_5	0.0154		0.0154	
nC_5	0.0139		0.0139	
C_6	0.0080		0.0080	
C_7+	0.0055		0.0055	
Total	1.0000	0.0000	1.0000	

Gas Stream Properties

Molecular Mass	37.75	0.00	37.75	kg/kmole
Net Heating Value	59.55	0.00	59.55	10^3 m³/d at 15°C and 101.3 kPa
Net Heat Release Rate	82,314	0	82,314	cal/s
Equivalent SO_2 Inlet	0.019	0.000	0.019	t/d
Equivalent SO_2 Inlet	0.22	0.00	0.22	g/s

Stack Parameters

Flare Stack Height	5.0	m	
Flare Stack Diameter	76.00	mm	
Actual Exit Velocity	1.28	m/s	
Length of Flame:	1.29	m	
Heat Intensity at Base	1.46	kW/m²	Background = 1.04 kW/m²
Conversion Efficiency	100.00	%	
Radiation Loss	55	%	(Brode => 55%, AENV => 25%)
Sensible Heat Release	37,041	cal/s	Based on conversion efficiency & radiation loss

Model Input Parameters

Effective Stack Height	6.02	m	(per EPA and Beychok, M.; 1979)
Pseudo-diameter	**0.753**	**m**	based on actual exit velocity
Actual Exit Velocity	1.28	m/s	
Exit Temperature	1273	K	1000 °C
Ambient temperature	288	K	Pseudo temperature for modelling

Emissions

SO_2 Emission	0.218	g/s	Based on user-specified conversion efficiency
H_2S 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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Version 5 (Compatible with EUB Spreadsheet)

```
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Flare SO2    55%              Case 2

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .218000
   STACK HEIGHT (M)       =       6.0200
   STK INSIDE DIAM (M)    =        .7530
   STK EXIT VELOCITY (M/S)=       1.2800
   STK GAS EXIT TEMP (K)  =    1273.0000
   AMBIENT AIR TEMP (K)   =     288.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =    1.377 M**4/S**3;  MOM. FLUX =     .053 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)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
100.	65.62	4	8.0	8.0	2560.0	7.41	8.26	4.75	NO
200.	56.82	4	4.0	4.0	1280.0	11.05	15.68	8.72	NO
300.	45.41	4	2.5	2.5	800.0	15.42	22.82	12.49	NO
400.	37.65	4	2.0	2.0	640.0	18.34	29.71	15.76	NO
500.	31.65	4	1.5	1.5	480.0	23.20	36.52	19.02	NO
600.	28.00	4	1.5	1.5	480.0	23.20	43.03	21.84	NO
700.	24.37	4	1.5	1.5	480.0	23.20	49.46	24.59	NO
800.	22.09	4	1.0	1.0	320.0	32.92	56.12	27.89	NO
900.	20.37	4	1.0	1.0	320.0	32.92	62.37	30.48	NO
1000.	18.65	4	1.0	1.0	320.0	32.92	68.57	33.02	NO
1100.	17.05	4	1.0	1.0	320.0	32.92	74.72	35.00	NO
1200.	16.47	6	1.0	1.0	10000.0	32.97	40.77	17.49	NO
1300.	16.94	6	1.0	1.0	10000.0	32.97	43.74	18.22	NO
1400.	17.24	6	1.0	1.0	10000.0	32.97	46.70	18.94	NO
1500.	17.40	6	1.0	1.0	10000.0	32.97	49.65	19.64	NO
1600.	17.44	6	1.0	1.0	10000.0	32.97	52.58	20.33	NO
1700.	17.38	6	1.0	1.0	10000.0	32.97	55.49	21.01	NO
1800.	17.25	6	1.0	1.0	10000.0	32.97	58.39	21.68	NO
1900.	17.06	6	1.0	1.0	10000.0	32.97	61.28	22.34	NO
2000.	16.82	6	1.0	1.0	10000.0	32.97	64.15	22.99	NO
2100.	16.50	6	1.0	1.0	10000.0	32.97	67.01	23.54	NO
2200.	16.15	6	1.0	1.0	10000.0	32.97	69.86	24.08	NO
2300.	15.81	6	1.0	1.0	10000.0	32.97	72.70	24.61	NO
2400.	15.46	6	1.0	1.0	10000.0	32.97	75.52	25.13	NO
2500.	15.11	6	1.0	1.0	10000.0	32.97	78.34	25.64	NO
2600.	14.77	6	1.0	1.0	10000.0	32.97	81.14	26.14	NO
2700.	14.43	6	1.0	1.0	10000.0	32.97	83.93	26.64	NO
2800.	14.09	6	1.0	1.0	10000.0	32.97	86.72	27.12	NO
2900.	13.77	6	1.0	1.0	10000.0	32.97	89.49	27.61	NO
3000.	13.45	6	1.0	1.0	10000.0	32.97	92.25	28.08	NO
3500.	11.94	6	1.0	1.0	10000.0	32.97	105.94	30.01	NO
4000.	10.68	6	1.0	1.0	10000.0	32.97	119.42	31.81	NO
4500.	9.615	6	1.0	1.0	10000.0	32.97	132.73	33.49	NO

```
  5000.   8.718        6     1.0    1.0 10000.0   32.97  145.88   35.08    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   109.   66.42        4     8.0    8.0  2560.0    7.41    9.01    5.15    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        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN       66.42          109.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

```
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Flare SO2         55%         Case 3

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        FLARE
   EMISSION RATE (G/S)    =      .218000
   FLARE STACK HEIGHT (M) =       5.0000
   TOT HEAT RLS (CAL/S)   =      82314.0
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   EFF RELEASE HEIGHT (M) =       6.0199
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =    1.365 M**4/S**3;  MOM. FLUX =     .832 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)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
100.	46.93	3	5.0	5.0	1600.0	11.43	12.56	7.60	NO
200.	43.37	4	4.5	4.5	1440.0	12.03	15.66	8.67	NO
300.	39.24	4	3.0	3.0	960.0	15.04	22.76	12.36	NO
400.	34.33	4	2.0	2.0	640.0	19.55	29.71	15.75	NO
500.	29.93	4	1.5	1.5	480.0	24.06	36.51	19.01	NO
600.	26.84	4	1.5	1.5	480.0	24.06	43.03	21.83	NO
700.	23.57	4	1.5	1.5	480.0	24.06	49.46	24.58	NO
800.	21.95	4	1.0	1.0	320.0	33.07	56.11	27.88	NO
900.	20.26	4	1.0	1.0	320.0	33.07	62.36	30.46	NO
1000.	18.56	4	1.0	1.0	320.0	33.07	68.56	33.01	NO
1100.	16.98	4	1.0	1.0	320.0	33.07	74.71	34.99	NO
1200.	15.78	6	1.0	1.0	10000.0	33.38	40.77	17.50	NO
1300.	16.28	6	1.0	1.0	10000.0	33.38	43.75	18.23	NO
1400.	16.62	6	1.0	1.0	10000.0	33.38	46.71	18.95	NO
1500.	16.81	6	1.0	1.0	10000.0	33.38	49.65	19.65	NO
1600.	16.88	6	1.0	1.0	10000.0	33.38	52.58	20.34	NO
1700.	16.86	6	1.0	1.0	10000.0	33.38	55.49	21.02	NO
1800.	16.77	6	1.0	1.0	10000.0	33.38	58.39	21.69	NO
1900.	16.61	6	1.0	1.0	10000.0	33.38	61.28	22.35	NO
2000.	16.40	6	1.0	1.0	10000.0	33.38	64.15	23.00	NO
2100.	16.10	6	1.0	1.0	10000.0	33.38	67.01	23.55	NO
2200.	15.79	6	1.0	1.0	10000.0	33.38	69.86	24.08	NO
2300.	15.46	6	1.0	1.0	10000.0	33.38	72.70	24.61	NO
2400.	15.13	6	1.0	1.0	10000.0	33.38	75.52	25.13	NO
2500.	14.81	6	1.0	1.0	10000.0	33.38	78.34	25.64	NO
2600.	14.48	6	1.0	1.0	10000.0	33.38	81.14	26.15	NO
2700.	14.16	6	1.0	1.0	10000.0	33.38	83.94	26.64	NO
2800.	13.84	6	1.0	1.0	10000.0	33.38	86.72	27.13	NO
2900.	13.52	6	1.0	1.0	10000.0	33.38	89.49	27.61	NO
3000.	13.22	6	1.0	1.0	10000.0	33.38	92.25	28.09	NO
3500.	11.76	6	1.0	1.0	10000.0	33.38	105.94	30.02	NO
4000.	10.53	6	1.0	1.0	10000.0	33.38	119.43	31.81	NO
4500.	9.500	6	1.0	1.0	10000.0	33.38	132.73	33.50	NO
5000.	8.623	6	1.0	1.0	10000.0	33.38	145.88	35.09	NO

```
MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   112.   47.38        3     4.5    4.5  1440.0   12.03   14.06    8.50    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        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      47.38          112.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

Sour Gas Flare Properties

Company	ABC oil
Facility	Battery Example
Case	Solution Gas Flaring (55% case)

Flow Rate

Gas Stream	Solution	None	To Flare	
Flow Rate	0.500	0.000	0.500	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)

H_2	0.0000		0.0000	Mole Fraction
He	0.0004		0.0004	
N_2	0.1485		0.1485	
CO_2	0.0693		0.0693	
H_2S	0.0139		0.0139	
C_1	0.1085		0.1085	
C_2	0.2620		0.2620	
C_3	0.2511		0.2511	
iC_4	0.0325		0.0325	
nC_4	0.0710		0.0710	
iC_5	0.0154		0.0154	
nC_5	0.0139		0.0139	
C_6	0.0080		0.0080	
C_7+	0.0055		0.0055	
Total	1.0000	0.0000	1.0000	

Gas Stream Properties

Molecular Mass	37.75	0.00	37.75	kg/kmole
Net Heating Value	59.55	0.00	59.55	10^3 m^3/d at 15°C and 101.3 kPa
Net Heat Release Rate	82,314	0	82,314	cal/s
Equivalent SO_2 Inlet	0.019	0.000	0.019	t/d
Equivalent SO_2 Inlet	0.22	0.00	0.22	g/s

Stack Parameters

Flare Stack Height	5.0	m	
Flare Stack Diameter	76.00	mm	
Actual Exit Velocity	20.00	m/s	
Length of Flame:	1.29	m	
Heat Intensity at Base	1.46	kW/m^2	Background = 1.04 kW/m^2
Conversion Efficiency	100.00	%	
Radiation Loss	55	%	(Brode => 55%, AENV => 25%)
Sensible Heat Release	37,041	cal/s	Based on conversion efficiency & radiation loss

Model Input Parameters

Effective Stack Height	6.02	m	(per EPA and Beychok,M.; 1979)
Pseudo-diameter	**0.190**	**m**	based on actual exit velocity
Actual Exit Velocity	20.00	m/s	
Exit Temperature	1273	K	1000 °C
Ambient temperature	288	K	Pseudo temperature for modelling

Emissions

SO_2 Emission	0.218	g/s	Based on user-specified conversion efficiency
H_2S 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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Version 5 (Compatible with EUB Spreadsheet)
02/07/02

22:05:05

```
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Flare SO2         55%         Case 4

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .218000
   STACK HEIGHT (M)       =       6.0200
   STK INSIDE DIAM (M)    =        .1900
   STK EXIT VELOCITY (M/S)=      20.0000
   STK GAS EXIT TEMP (K)  =    1273.0000
   AMBIENT AIR TEMP (K)   =     288.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =    1.370 M**4/S**3;  MOM. FLUX =     .817 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)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
100.	46.80	3	5.0	5.0	1600.0	11.44	12.56	7.60	NO
200.	43.26	4	4.5	4.5	1440.0	12.05	15.66	8.67	NO
300.	39.15	4	3.0	3.0	960.0	15.06	22.76	12.37	NO
400.	34.24	4	2.0	2.0	640.0	19.58	29.71	15.75	NO
500.	29.84	4	1.5	1.5	480.0	24.10	36.51	19.01	NO
600.	26.77	4	1.5	1.5	480.0	24.10	43.03	21.83	NO
700.	23.53	4	1.5	1.5	480.0	24.10	49.46	24.58	NO
800.	21.88	4	1.0	1.0	320.0	33.14	56.11	27.88	NO
900.	20.21	4	1.0	1.0	320.0	33.14	62.37	30.47	NO
1000.	18.52	4	1.0	1.0	320.0	33.14	68.57	33.02	NO
1100.	16.95	4	1.0	1.0	320.0	33.14	74.71	34.99	NO
1200.	15.96	6	1.0	1.0	10000.0	33.25	40.76	17.48	NO
1300.	16.46	6	1.0	1.0	10000.0	33.25	43.74	18.22	NO
1400.	16.78	6	1.0	1.0	10000.0	33.25	46.70	18.93	NO
1500.	16.97	6	1.0	1.0	10000.0	33.25	49.64	19.64	NO
1600.	17.04	6	1.0	1.0	10000.0	33.25	52.57	20.33	NO
1700.	17.01	6	1.0	1.0	10000.0	33.25	55.49	21.01	NO
1800.	16.90	6	1.0	1.0	10000.0	33.25	58.39	21.68	NO
1900.	16.74	6	1.0	1.0	10000.0	33.25	61.28	22.34	NO
2000.	16.53	6	1.0	1.0	10000.0	33.25	64.15	22.98	NO
2100.	16.21	6	1.0	1.0	10000.0	33.25	67.01	23.53	NO
2200.	15.89	6	1.0	1.0	10000.0	33.25	69.86	24.07	NO
2300.	15.56	6	1.0	1.0	10000.0	33.25	72.70	24.60	NO
2400.	15.23	6	1.0	1.0	10000.0	33.25	75.52	25.12	NO
2500.	14.90	6	1.0	1.0	10000.0	33.25	78.34	25.63	NO
2600.	14.57	6	1.0	1.0	10000.0	33.25	81.14	26.14	NO
2700.	14.24	6	1.0	1.0	10000.0	33.25	83.93	26.63	NO
2800.	13.91	6	1.0	1.0	10000.0	33.25	86.71	27.12	NO
2900.	13.60	6	1.0	1.0	10000.0	33.25	89.49	27.60	NO
3000.	13.29	6	1.0	1.0	10000.0	33.25	92.25	28.08	NO
3500.	11.81	6	1.0	1.0	10000.0	33.25	105.94	30.01	NO
4000.	10.58	6	1.0	1.0	10000.0	33.25	119.42	31.80	NO
4500.	9.535	6	1.0	1.0	10000.0	33.25	132.73	33.49	NO
5000.	8.652	6	1.0	1.0	10000.0	33.25	145.88	35.08	NO

```
MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   112.   47.26        3     4.5    4.5  1440.0   12.05   14.06    8.50    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         MAX CONC    DIST TO   TERRAIN
  PROCEDURE         (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      47.26          112.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

Input Cases:

The following **TANK VENT** examples are provided:

Source Parameters	Case 1	Case 2	Case 3	Case 4
Stack height (m)	10.31	10.31	10.31	10.31
Stack diameter (m)	0.076	0.076	0.076	0.076
Stack gas exit velocity (m/s)	0.00	0.00	0.00	**0.5**
Stack gas exit temperature (K)	293	293	293	**303**
H_2S emission rate (g/s)	0.20	0.20	0.20	0.20
Tank height (m)	0.0	**7.31**	**7.31**	**7.31**
Tank Diameter (m)	0.0	**3.34**	**3.34**	**3.34**
Meteorology	Full	Full	Full	Full
Ambient Temperature (K)	293	293	293	293
Dispersion	Rural	Rural	Rural	Rural
Minimum/Maximum Distances (m)	100 5000	100 5000	**10** **200**	**10** **200**
Terrain	Flat	Flat	Flat	Flat
Input values that have changed from the Base Case (Case 1) are shown in boldface text.				

Interpretation:

Case	**Case 1**	**Case 2**	**Case 3**	**Case 4**
Maximum H_2S ($\mu g/m^3$)	27	**70**	**108**	**67**
Downwind distance (m)	100	100	**50**	**50**
PG Stability Class	C (3)	**F (6)**	**F (6)**	**F (6)**
10-m Wind Speed (m/s)	1.0	1.0	1.0	1.0
Mixing Height (m)	320	**10000**	**10000**	**10000**
Building Cavity H_2S ($\mu g/m^3$)	-	**546**	**546**	**546**
Distance to Cavity Maximum (m)	-	**546**	**546**	**546**
Input values that have changed from the Base Case (Case 1) are shown in boldface text.				

Case 1 assumes no exit velocity, an exit temperature equal to ambient and no tank wake effects.

Case 2 assumes tank wake effects, which increases the ambient concentration predictions.

Case 3 demonstrates that the maximum concentration is predicted to be closer to the tank vent than the 100 m minimum assumed for Cases 1 and 2.

Case 4 shows the effects of assuming an exit velocity and assuming the gas exit temperature is 10 °C warmer than ambient.

02/08/02
12:37:14

```
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Tank H2S               Case 1

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .200000E-01
   STACK HEIGHT (M)       =      10.3100
   STK INSIDE DIAM (M)    =        .0760
   STK EXIT VELOCITY (M/S)=        .0000
   STK GAS EXIT TEMP (K)  =     293.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 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)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
100.	27.33	3	1.0	1.0	320.0	10.08	12.46	7.44	NO
200.	23.71	4	1.0	1.0	320.0	10.08	15.56	8.50	NO
300.	21.89	5	1.0	1.0	10000.0	10.08	16.89	8.70	NO
400.	21.81	6	1.0	1.0	10000.0	10.08	14.64	7.05	NO
500.	20.18	6	1.0	1.0	10000.0	10.08	17.97	8.40	NO
600.	17.71	6	1.0	1.0	10000.0	10.08	21.24	9.69	NO
700.	15.30	6	1.0	1.0	10000.0	10.08	24.46	10.93	NO
800.	13.27	6	1.0	1.0	10000.0	10.08	27.63	11.98	NO
900.	11.59	6	1.0	1.0	10000.0	10.08	30.78	12.98	NO
1000.	10.20	6	1.0	1.0	10000.0	10.08	33.88	13.95	NO
1100.	9.067	6	1.0	1.0	10000.0	10.08	36.96	14.82	NO
1200.	8.121	6	1.0	1.0	10000.0	10.08	40.01	15.66	NO
1300.	7.322	6	1.0	1.0	10000.0	10.08	43.04	16.47	NO
1400.	6.641	6	1.0	1.0	10000.0	10.08	46.05	17.26	NO
1500.	6.057	6	1.0	1.0	10000.0	10.08	49.03	18.03	NO
1600.	5.551	6	1.0	1.0	10000.0	10.08	51.99	18.78	NO
1700.	5.109	6	1.0	1.0	10000.0	10.08	54.94	19.52	NO
1800.	4.722	6	1.0	1.0	10000.0	10.08	57.87	20.23	NO
1900.	4.381	6	1.0	1.0	10000.0	10.08	60.78	20.94	NO
2000.	4.078	6	1.0	1.0	10000.0	10.08	63.68	21.63	NO
2100.	3.820	6	1.0	1.0	10000.0	10.08	66.56	22.21	NO
2200.	3.589	6	1.0	1.0	10000.0	10.08	69.42	22.78	NO
2300.	3.380	6	1.0	1.0	10000.0	10.08	72.28	23.34	NO
2400.	3.191	6	1.0	1.0	10000.0	10.08	75.12	23.89	NO
2500.	3.020	6	1.0	1.0	10000.0	10.08	77.95	24.42	NO
2600.	2.863	6	1.0	1.0	10000.0	10.08	80.76	24.95	NO
2700.	2.719	6	1.0	1.0	10000.0	10.08	83.57	25.47	NO
2800.	2.588	6	1.0	1.0	10000.0	10.08	86.36	25.98	NO
2900.	2.466	6	1.0	1.0	10000.0	10.08	89.15	26.48	NO
3000.	2.354	6	1.0	1.0	10000.0	10.08	91.92	26.98	NO
3500.	1.925	6	1.0	1.0	10000.0	10.08	105.65	28.98	NO
4000.	1.615	6	1.0	1.0	10000.0	10.08	119.17	30.84	NO
4500.	1.383	6	1.0	1.0	10000.0	10.08	132.50	32.57	NO

```
  5000.   1.203        6     1.0    1.0 10000.0   10.08  145.67   34.21    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   100.   27.33        3     1.0    1.0   320.0   10.08   12.46    7.44    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        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      27.33          100.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

```
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Tank H2S               Case 2

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .200000E-01
   STACK HEIGHT (M)       =      10.3100
   STK INSIDE DIAM (M)    =        .0760
   STK EXIT VELOCITY (M/S)=        .0000
   STK GAS EXIT TEMP (K)  =     293.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =       7.3100
   MIN HORIZ BLDG DIM (M) =       3.3400
   MAX HORIZ BLDG DIM (M) =       3.3400

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


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 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)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
100.	69.96	6	1.0	1.0	10000.0	10.08	4.07	6.43	HS
200.	45.07	6	1.0	1.0	10000.0	10.08	7.73	7.81	HS
300.	33.17	6	1.0	1.0	10000.0	10.08	11.23	9.12	HS
400.	25.71	6	1.0	1.0	10000.0	10.08	14.64	10.38	HS
500.	20.76	6	1.0	1.0	10000.0	10.08	17.97	11.15	HS
600.	17.18	6	1.0	1.0	10000.0	10.08	21.24	12.19	HS
700.	14.49	6	1.0	1.0	10000.0	10.08	24.46	13.19	HS
800.	12.53	6	1.0	1.0	10000.0	10.08	27.63	13.89	HS
900.	10.91	6	1.0	1.0	10000.0	10.08	30.78	14.76	HS
1000.	9.610	6	1.0	1.0	10000.0	10.08	33.88	15.60	HS
1100.	8.543	6	1.0	1.0	10000.0	10.08	36.96	16.42	HS
1200.	7.657	6	1.0	1.0	10000.0	10.08	40.01	17.21	HS
1300.	6.912	6	1.0	1.0	10000.0	10.08	43.04	17.98	HS
1400.	6.279	6	1.0	1.0	10000.0	10.08	46.05	18.73	HS
1500.	5.736	6	1.0	1.0	10000.0	10.08	49.03	19.47	HS
1600.	5.265	6	1.0	1.0	10000.0	10.08	51.99	20.19	HS
1700.	4.855	6	1.0	1.0	10000.0	10.08	54.94	20.89	HS
1800.	4.494	6	1.0	1.0	10000.0	10.08	57.87	21.58	HS
1900.	4.250	6	1.0	1.0	10000.0	10.08	60.78	21.77	HS
2000.	3.973	6	1.0	1.0	10000.0	10.08	63.68	22.35	HS
2100.	3.726	6	1.0	1.0	10000.0	10.08	66.56	22.92	HS
2200.	3.503	6	1.0	1.0	10000.0	10.08	69.42	23.47	HS
2300.	3.302	6	1.0	1.0	10000.0	10.08	72.28	24.02	HS
2400.	3.120	6	1.0	1.0	10000.0	10.08	75.12	24.55	HS
2500.	2.954	6	1.0	1.0	10000.0	10.08	77.95	25.08	HS
2600.	2.802	6	1.0	1.0	10000.0	10.08	80.76	25.59	HS
2700.	2.664	6	1.0	1.0	10000.0	10.08	83.57	26.10	HS
2800.	2.536	6	1.0	1.0	10000.0	10.08	86.36	26.60	HS
2900.	2.444	6	1.0	1.0	10000.0	10.08	89.15	26.77	HS
3000.	2.336	6	1.0	1.0	10000.0	10.08	91.92	27.21	HS
3500.	1.912	6	1.0	1.0	10000.0	10.08	105.65	29.20	HS
4000.	1.605	6	1.0	1.0	10000.0	10.08	119.17	31.04	HS
4500.	1.375	6	1.0	1.0	10000.0	10.08	132.50	32.76	HS

```
  5000.   1.197        6     1.0    1.0 10000.0   10.08  145.67   34.39    HS

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   100.   69.96        6     1.0    1.0 10000.0   10.08    4.07    6.43    HS

 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

****************************************
     *** REGULATORY (Default) ***
    PERFORMING CAVITY CALCULATIONS
  WITH ORIGINAL SCREEN CAVITY MODEL
          (BRODE, 1988)
****************************************


 *** CAVITY CALCULATION - 1 ***       *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)     =    546.1        CONC (UG/M**3)     =    546.1
  CRIT WS @10M (M/S) =     1.00        CRIT WS @10M (M/S) =     1.00
  CRIT WS @ HS (M/S) =     1.01        CRIT WS @ HS (M/S) =     1.01
  DILUTION WS (M/S)  =     1.00        DILUTION WS (M/S)  =     1.00
  CAVITY HT (M)      =    13.77        CAVITY HT (M)      =    13.77
  CAVITY LENGTH (M)  =     8.42        CAVITY LENGTH (M)  =     8.42
  ALONGWIND DIM (M)  =     3.34        ALONGWIND DIM (M)  =     3.34

****************************************
      END OF CAVITY CALCULATIONS
****************************************


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

 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      69.96          100.        0.

BLDG. CAVITY-1      546.1            8.       --  (DIST = CAVITY LENGTH)

BLDG. CAVITY-2      546.1            8.       --  (DIST = CAVITY LENGTH)


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

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                                                                02/08/02
                                                                12:44:19
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Tank H2S               Case 3

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .200000E-01
   STACK HEIGHT (M)       =      10.3100
   STK INSIDE DIAM (M)    =        .0760
   STK EXIT VELOCITY (M/S)=        .0000
   STK GAS EXIT TEMP (K)  =     293.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =       7.3100
   MIN HORIZ BLDG DIM (M) =       3.3400
   MAX HORIZ BLDG DIM (M) =       3.3400

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


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** FULL METEOROLOGY ***

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

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

  DIST     CONC            U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
    10.   .0000        0      .0     .0      .0     .00     .00     .00    NA
    20.   45.20        6     1.0    1.0 10000.0   10.08     .91    3.70    HS
    30.   75.14        6     1.0    1.0 10000.0   10.08    1.33    4.37    HS
    40.   96.57        6     1.0    1.0 10000.0   10.08    1.74    5.04    HS
    50.   107.9        6     1.0    1.0 10000.0   10.08    2.14    5.71    HS
    60.   95.86        6     1.0    1.0 10000.0   10.08    2.53    5.85    HS
    70.   87.00        6     1.0    1.0 10000.0   10.08    2.92    6.00    HS
    80.   80.12        6     1.0    1.0 10000.0   10.08    3.31    6.14    HS
    90.   74.57        6     1.0    1.0 10000.0   10.08    3.69    6.29    HS
   100.   69.96        6     1.0    1.0 10000.0   10.08    4.07    6.43    HS
   110.   66.04        6     1.0    1.0 10000.0   10.08    4.45    6.57    HS
   120.   62.63        6     1.0    1.0 10000.0   10.08    4.82    6.71    HS
   130.   59.62        6     1.0    1.0 10000.0   10.08    5.19    6.85    HS
   140.   56.94        6     1.0    1.0 10000.0   10.08    5.56    6.99    HS
   150.   54.52        6     1.0    1.0 10000.0   10.08    5.92    7.13    HS
   160.   52.31        6     1.0    1.0 10000.0   10.08    6.29    7.26    HS
   170.   50.29        6     1.0    1.0 10000.0   10.08    6.65    7.40    HS
   180.   48.42        6     1.0    1.0 10000.0   10.08    7.01    7.54    HS
   200.   45.07        6     1.0    1.0 10000.0   10.08    7.73    7.81    HS

 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

****************************************
     *** REGULATORY (Default) ***
    PERFORMING CAVITY CALCULATIONS
  WITH ORIGINAL SCREEN CAVITY MODEL
         (BRODE, 1988)
****************************************
```

```
 *** CAVITY CALCULATION - 1 ***       *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)     =    546.1        CONC (UG/M**3)     =    546.1
  CRIT WS @10M (M/S) =     1.00        CRIT WS @10M (M/S) =     1.00
  CRIT WS @ HS (M/S) =     1.01        CRIT WS @ HS (M/S) =     1.01
  DILUTION WS (M/S)  =     1.00        DILUTION WS (M/S)  =     1.00
  CAVITY HT (M)      =    13.77        CAVITY HT (M)      =    13.77
  CAVITY LENGTH (M)  =     8.42        CAVITY LENGTH (M)  =     8.42
  ALONGWIND DIM (M)  =     3.34        ALONGWIND DIM (M)  =     3.34

****************************************
      END OF CAVITY CALCULATIONS
****************************************


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

 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      107.9           50.        0.

BLDG. CAVITY-1      546.1            8.       --  (DIST = CAVITY LENGTH)

BLDG. CAVITY-2      546.1            8.       --  (DIST = CAVITY LENGTH)


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
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```
                                                         02/08/02
                                                         12:51:04
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Tank H2S               Case 4

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .200000E-01
   STACK HEIGHT (M)       =      10.3100
   STK INSIDE DIAM (M)    =        .0760
   STK EXIT VELOCITY (M/S)=        .5000
   STK GAS EXIT TEMP (K)  =     303.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =       7.3100
   MIN HORIZ BLDG DIM (M) =       3.3400
   MAX HORIZ BLDG DIM (M) =       3.3400

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


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** FULL METEOROLOGY ***

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

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

  DIST     CONC            U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
    10.   .0000        0      .0     .0      .0     .00     .00     .00    NA
    20.   24.38        6     1.0    1.0 10000.0   10.87     .93    3.70    HS
    30.   42.47        6     1.0    1.0 10000.0   11.09    1.35    4.38    HS
    40.   57.54        6     1.0    1.0 10000.0   11.29    1.77    5.05    HS
    50.   67.53        6     1.0    1.0 10000.0   11.47    2.17    5.72    HS
    60.   58.11        6     1.0    1.0 10000.0   11.64    2.57    5.87    HS
    70.   53.69        6     1.0    1.0 10000.0   11.67    2.95    6.02    HS
    80.   50.64        6     1.0    1.0 10000.0   11.67    3.34    6.16    HS
    90.   48.16        6     1.0    1.0 10000.0   11.67    3.72    6.30    HS
   100.   46.08        6     1.0    1.0 10000.0   11.67    4.09    6.44    HS
   110.   44.29        6     1.0    1.0 10000.0   11.67    4.47    6.58    HS
   120.   42.71        6     1.0    1.0 10000.0   11.67    4.84    6.72    HS
   130.   41.30        6     1.0    1.0 10000.0   11.67    5.21    6.86    HS
   140.   40.02        6     1.0    1.0 10000.0   11.67    5.57    7.00    HS
   150.   38.84        6     1.0    1.0 10000.0   11.67    5.94    7.14    HS
   160.   37.75        6     1.0    1.0 10000.0   11.67    6.30    7.28    HS
   170.   36.72        6     1.0    1.0 10000.0   11.67    6.66    7.41    HS
   180.   35.76        6     1.0    1.0 10000.0   11.67    7.02    7.55    HS
   200.   33.97        6     1.0    1.0 10000.0   11.67    7.74    7.82    HS

 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

****************************************
     *** REGULATORY (Default) ***
    PERFORMING CAVITY CALCULATIONS
  WITH ORIGINAL SCREEN CAVITY MODEL
         (BRODE, 1988)
****************************************
```

```
 *** CAVITY CALCULATION - 1 ***       *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)     =    546.1        CONC (UG/M**3)     =    546.1
  CRIT WS @10M (M/S) =     1.00        CRIT WS @10M (M/S) =     1.00
  CRIT WS @ HS (M/S) =     1.01        CRIT WS @ HS (M/S) =     1.01
  DILUTION WS (M/S)  =     1.00        DILUTION WS (M/S)  =     1.00
  CAVITY HT (M)      =    13.77        CAVITY HT (M)      =    13.77
  CAVITY LENGTH (M)  =     8.42        CAVITY LENGTH (M)  =     8.42
  ALONGWIND DIM (M)  =     3.34        ALONGWIND DIM (M)  =     3.34

****************************************
      END OF CAVITY CALCULATIONS
****************************************


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

 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      67.53          50.        0.

BLDG. CAVITY-1      546.1           8.       --  (DIST = CAVITY LENGTH)

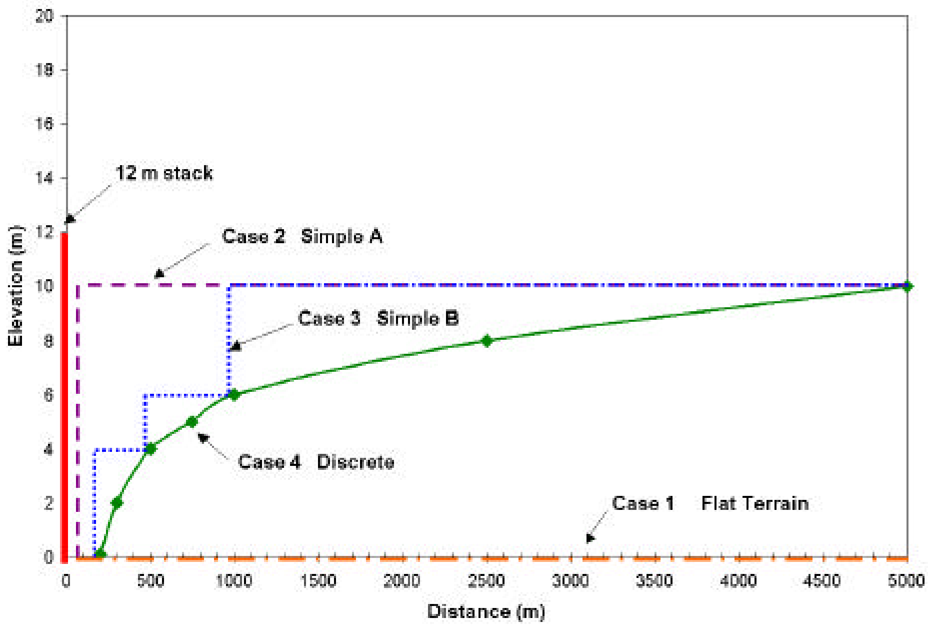
BLDG. CAVITY-2      546.1           8.       --  (DIST = CAVITY LENGTH)


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

Input Cases:

The following **RECEPTOR/SIMPLE TERRAIN** examples are provided:

Source Parameters	**Case 1**	**Case 2**	**Case 3**	**Case 4**
Stack height (m)	12	12	12	12
Stack diameter (m)	0.30	0.30	0.30	0.30
Stack gas exit velocity (m/s)	2.5	2.5	2.5	2.5
Stack gas exit temperature (K)	573	573	573	573
SO_2 emission rate (g/s)	0.5	0.5	0.5	0.5
Meteorology	Full	Full	Full	Full
Ambient Temperature (K)	293	293	293	293
Dispersion	Rural	Rural	Rural	Rural
Receptors	Automated	Automated	Automated	**Discrete**
Terrain	Flat	**Simple A**	**Simple B**	**Simple**
Elevations (Elevation: Distance Range)	0 m: 100 to 5000 m	**10 m: 100 to 5000 m**	**0 m: 100 to 200 m 4 m: 200 to 500 m 6 m: 500 to 1000 m 10 m: 1000 to 5000 m**	**Various**
Minimum/Maximum Distances (m)	100 5000	100 5000	100 5000	100 5000
Input values that have changed from the Base Case (Case 1) are shown in boldface text.				



Interpretation:

Case	Case 1	Case 2	Case 3	Case 4
Maximum SO_2 ($\mu g/m^3$)	174	**955**	**249**	**194**
Downwind distance (m)	196	**100**	**261**	**300**
PG Stability Class	C (3)	**D (4)**	**D (4)**	**D (4)**
10-m Wind Speed (m/s)	1.0	**2.0**	1.0	1.0
Mixing Height (m)	320	**640**	320	320
Input values that have changed from the Base Case (Case 1) are shown in boldface text.				

Case 1 is a base case flat terrain case assuming automated receptors between 100 and 5000 m.

Case 2 conservatively assumes all terrain is 10 m above stack base for the automated receptors..

Case 3 treats the elevated receptors as a series of “steps”.

Case 4 uses discrete receptors to represent the actual terrain. If the receptor spacing is too big, the user may not see the peak value.

02/09/02
13:01:49

```
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Receptor/Terrain               Case 1  Flat

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HEIGHT (M)       =      12.0000
   STK INSIDE DIAM (M)    =        .3000
   STK EXIT VELOCITY (M/S)=       2.5000
   STK GAS EXIT TEMP (K)  =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =     .270 M**4/S**3;  MOM. FLUX =     .072 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)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
100.	152.9	1	1.0	1.0	320.0	19.91	26.95	14.13	NO
200.	174.3	3	1.0	1.0	320.0	19.87	23.73	14.21	NO
300.	151.6	4	1.0	1.0	320.0	19.80	22.72	12.30	NO
400.	149.2	4	1.0	1.0	320.0	19.80	29.54	15.43	NO
500.	130.3	4	1.0	1.0	320.0	19.80	36.21	18.43	NO
600.	110.3	4	1.0	1.0	320.0	19.80	42.78	21.33	NO
700.	93.08	4	1.0	1.0	320.0	19.80	49.24	24.14	NO
800.	78.98	4	1.0	1.0	320.0	19.80	55.62	26.87	NO
900.	67.62	4	1.0	1.0	320.0	19.80	61.92	29.55	NO
1000.	58.44	4	1.0	1.0	320.0	19.80	68.16	32.17	NO
1100.	51.96	6	1.0	1.1	10000.0	27.41	37.22	15.46	NO
1200.	53.16	6	1.0	1.1	10000.0	27.41	40.26	16.26	NO
1300.	53.60	6	1.0	1.1	10000.0	27.41	43.27	17.05	NO
1400.	53.49	6	1.0	1.1	10000.0	27.41	46.26	17.81	NO
1500.	52.96	6	1.0	1.1	10000.0	27.41	49.23	18.56	NO
1600.	52.13	6	1.0	1.1	10000.0	27.41	52.18	19.29	NO
1700.	51.08	6	1.0	1.1	10000.0	27.41	55.12	20.01	NO
1800.	49.89	6	1.0	1.1	10000.0	27.41	58.03	20.71	NO
1900.	48.61	6	1.0	1.1	10000.0	27.41	60.94	21.39	NO
2000.	47.27	6	1.0	1.1	10000.0	27.41	63.83	22.07	NO
2100.	45.82	6	1.0	1.1	10000.0	27.41	66.70	22.64	NO
2200.	44.40	6	1.0	1.1	10000.0	27.41	69.56	23.20	NO
2300.	43.01	6	1.0	1.1	10000.0	27.41	72.41	23.75	NO
2400.	41.67	6	1.0	1.1	10000.0	27.41	75.25	24.29	NO
2500.	40.38	6	1.0	1.1	10000.0	27.41	78.07	24.82	NO
2600.	39.13	6	1.0	1.1	10000.0	27.41	80.88	25.34	NO
2700.	37.93	6	1.0	1.1	10000.0	27.41	83.69	25.85	NO
2800.	36.78	6	1.0	1.1	10000.0	27.41	86.48	26.35	NO
2900.	35.68	6	1.0	1.1	10000.0	27.41	89.26	26.85	NO
3000.	34.62	6	1.0	1.1	10000.0	27.41	92.03	27.33	NO
3500.	30.00	6	1.0	1.1	10000.0	27.41	105.74	29.31	NO
4000.	26.32	6	1.0	1.1	10000.0	27.41	119.25	31.15	NO
4500.	23.34	6	1.0	1.1	10000.0	27.41	132.58	32.87	NO

```
  5000.   20.89        6     1.0    1.1 10000.0   27.41  145.74   34.49    NO

 MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   196.   174.4        3     1.0    1.0   320.0   19.87   23.40   14.02    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        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      174.4          196.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
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02/09/02
13:07:00

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

Receptor/Terrain   Case 2   Simple A

SIMPLE TERRAIN INPUTS:

```
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HEIGHT (M)       =      12.0000
   STK INSIDE DIAM (M)    =        .3000
   STK EXIT VELOCITY (M/S)=       2.5000
   STK GAS EXIT TEMP (K)  =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000
```

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

BUOY. FLUX =   .270 M**4/S**3; MOM. FLUX =   .072 M**4/S**2.

*** FULL METEOROLOGY ***

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**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************
```

*** TERRAIN HEIGHT OF   10. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
100.	954.6	4	2.0	2.1	640.0	5.73	8.28	4.78	NO
200.	602.0	4	1.0	1.0	320.0	9.80	15.72	8.79	NO
300.	403.5	4	1.0	1.0	320.0	9.80	22.72	12.30	NO
400.	277.7	4	1.0	1.0	320.0	9.80	29.54	15.43	NO
500.	201.4	4	1.0	1.0	320.0	9.80	36.21	18.43	NO
600.	163.6	6	1.0	1.1	10000.0	17.41	21.69	10.64	NO
700.	165.1	6	1.0	1.1	10000.0	17.41	24.85	11.78	NO
800.	159.0	6	1.0	1.1	10000.0	17.41	27.98	12.76	NO
900.	150.8	6	1.0	1.1	10000.0	17.41	31.09	13.71	NO
1000.	141.9	6	1.0	1.1	10000.0	17.41	34.17	14.63	NO
1100.	132.7	6	1.0	1.1	10000.0	17.41	37.22	15.46	NO
1200.	124.0	6	1.0	1.1	10000.0	17.41	40.26	16.26	NO
1300.	115.9	6	1.0	1.1	10000.0	17.41	43.27	17.05	NO
1400.	108.4	6	1.0	1.1	10000.0	17.41	46.26	17.81	NO
1500.	101.5	6	1.0	1.1	10000.0	17.41	49.23	18.56	NO
1600.	95.19	6	1.0	1.1	10000.0	17.41	52.18	19.29	NO
1700.	89.42	6	1.0	1.1	10000.0	17.41	55.12	20.01	NO
1800.	84.14	6	1.0	1.1	10000.0	17.41	58.03	20.71	NO
1900.	79.30	6	1.0	1.1	10000.0	17.41	60.94	21.39	NO
2000.	74.88	6	1.0	1.1	10000.0	17.41	63.83	22.07	NO
2100.	70.93	6	1.0	1.1	10000.0	17.41	66.70	22.64	NO
2200.	67.32	6	1.0	1.1	10000.0	17.41	69.56	23.20	NO
2300.	63.99	6	1.0	1.1	10000.0	17.41	72.41	23.75	NO
2400.	60.93	6	1.0	1.1	10000.0	17.41	75.25	24.29	NO
2500.	58.10	6	1.0	1.1	10000.0	17.41	78.07	24.82	NO
2600.	55.48	6	1.0	1.1	10000.0	17.41	80.88	25.34	NO
2700.	53.05	6	1.0	1.1	10000.0	17.41	83.69	25.85	NO
2800.	50.79	6	1.0	1.1	10000.0	17.41	86.48	26.35	NO
2900.	48.69	6	1.0	1.1	10000.0	17.41	89.26	26.85	NO
3000.	46.73	6	1.0	1.1	10000.0	17.41	92.03	27.33	NO
3500.	38.94	6	1.0	1.1	10000.0	17.41	105.74	29.31	NO
4000.	33.15	6	1.0	1.1	10000.0	17.41	119.25	31.15	NO
4500.	28.72	6	1.0	1.1	10000.0	17.41	132.58	32.87	NO

```
  5000.   25.22        6     1.0    1.1 10000.0   17.41  145.74   34.49    NO

 MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   100.   954.6        4     2.0    2.1   640.0    5.73    8.28    4.78    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 TERRAIN HEIGHTS ENTERED FOR  *
  *    SIMPLE ELEVATED TERRAIN PROCEDURE     *
  ********************************************

       TERRAIN        DISTANCE RANGE (M)
        HT (M)       MINIMUM     MAXIMUM
       -------      --------    --------
           10.          100.       5000.

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

  CALCULATION        MAX CONC    DIST TO   TERRAIN
   PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
 --------------    -----------   -------   -------
 SIMPLE TERRAIN      954.6          100.       10.

 ***************************************************
 ** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
 ***************************************************
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                                                                          02/09/02
                                                                          13:10:15
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Receptor/Terrain               Case 3   Simple B

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HEIGHT (M)       =      12.0000
   STK INSIDE DIAM (M)    =        .3000
   STK EXIT VELOCITY (M/S)=       2.5000
   STK GAS EXIT TEMP (K)  =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =     .270 M**4/S**3;  MOM. FLUX =     .072 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
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   100.   152.9        1     1.0    1.0   320.0   19.91   26.95   14.13    NO
   200.   174.3        3     1.0    1.0   320.0   19.87   23.73   14.21    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   100. M:
   196.   174.4        3     1.0    1.0   320.0   19.87   23.40   14.02    NO

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

*** TERRAIN HEIGHT OF    4. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   200.   248.4        3     1.0    1.0   320.0   15.87   23.73   14.21    NO
   300.   242.8        4     1.0    1.0   320.0   15.80   22.72   12.30    NO
   400.   201.2        4     1.0    1.0   320.0   15.80   29.54   15.43    NO
   500.   160.7        4     1.0    1.0   320.0   15.80   36.21   18.43    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   200. M:
   261.   249.4        4     1.0    1.0   320.0   15.80   20.08   10.98    NO

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

*** TERRAIN HEIGHT OF    6. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   500.   175.3        4     1.0    1.0   320.0   13.80   36.21   18.43    NO
```

```
   600.   137.7        4     1.0    1.0   320.0   13.80   42.78   21.33    NO
   700.   110.7        4     1.0    1.0   320.0   13.80   49.24   24.14    NO
   800.   98.68        6     1.0    1.1 10000.0   21.41   27.98   12.76    NO
   900.   99.78        6     1.0    1.1 10000.0   21.41   31.09   13.71    NO
  1000.   98.73        6     1.0    1.1 10000.0   21.41   34.17   14.63    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
   500.   175.3        4     1.0    1.0   320.0   13.80   36.21   18.43    NO

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

*** TERRAIN HEIGHT OF   10. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
  1000.   141.9        6     1.0    1.1 10000.0   17.41   34.17   14.63    NO
  1100.   132.7        6     1.0    1.1 10000.0   17.41   37.22   15.46    NO
  1200.   124.0        6     1.0    1.1 10000.0   17.41   40.26   16.26    NO
  1300.   115.9        6     1.0    1.1 10000.0   17.41   43.27   17.05    NO
  1400.   108.4        6     1.0    1.1 10000.0   17.41   46.26   17.81    NO
  1500.   101.5        6     1.0    1.1 10000.0   17.41   49.23   18.56    NO
  1600.   95.19        6     1.0    1.1 10000.0   17.41   52.18   19.29    NO
  1700.   89.42        6     1.0    1.1 10000.0   17.41   55.12   20.01    NO
  1800.   84.14        6     1.0    1.1 10000.0   17.41   58.03   20.71    NO
  1900.   79.30        6     1.0    1.1 10000.0   17.41   60.94   21.39    NO
  2000.   74.88        6     1.0    1.1 10000.0   17.41   63.83   22.07    NO
  2100.   70.93        6     1.0    1.1 10000.0   17.41   66.70   22.64    NO
  2200.   67.32        6     1.0    1.1 10000.0   17.41   69.56   23.20    NO
  2300.   63.99        6     1.0    1.1 10000.0   17.41   72.41   23.75    NO
  2400.   60.93        6     1.0    1.1 10000.0   17.41   75.25   24.29    NO
  2500.   58.10        6     1.0    1.1 10000.0   17.41   78.07   24.82    NO
  2600.   55.48        6     1.0    1.1 10000.0   17.41   80.88   25.34    NO
  2700.   53.05        6     1.0    1.1 10000.0   17.41   83.69   25.85    NO
  2800.   50.79        6     1.0    1.1 10000.0   17.41   86.48   26.35    NO
  2900.   48.69        6     1.0    1.1 10000.0   17.41   89.26   26.85    NO
  3000.   46.73        6     1.0    1.1 10000.0   17.41   92.03   27.33    NO
  3500.   38.94        6     1.0    1.1 10000.0   17.41  105.74   29.31    NO
  4000.   33.15        6     1.0    1.1 10000.0   17.41  119.25   31.15    NO
  4500.   28.72        6     1.0    1.1 10000.0   17.41  132.58   32.87    NO
  5000.   25.22        6     1.0    1.1 10000.0   17.41  145.74   34.49    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND  1000. M:
  1000.   141.9        6     1.0    1.1 10000.0   17.41   34.17   14.63    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 TERRAIN HEIGHTS ENTERED FOR  *
 *    SIMPLE ELEVATED TERRAIN PROCEDURE     *
 ********************************************

      TERRAIN        DISTANCE RANGE (M)
       HT (M)       MINIMUM     MAXIMUM
      -------      --------    --------
          0.          100.        200.
          4.          200.        500.
          6.          500.       1000.
         10.         1000.       5000.

    ***************************************
    *** SUMMARY OF SCREEN MODEL RESULTS ***
    ***************************************
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CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	249.4	261.	4.

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***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
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 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Receptor/Terrain               Case 4  Discrete

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HEIGHT (M)       =      12.0000
   STK INSIDE DIAM (M)    =        .3000
   STK EXIT VELOCITY (M/S)=       2.5000
   STK GAS EXIT TEMP (K)  =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =     .270 M**4/S**3;  MOM. FLUX =     .072 M**4/S**2.

*** FULL METEOROLOGY ***

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    2. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   300.   194.4        4     1.0    1.0   320.0   17.80   22.72   12.30    NO

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    4. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   500.   160.7        4     1.0    1.0   320.0   15.80   36.21   18.43    NO

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    5. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   750.   97.83        4     1.0    1.0   320.0   14.80   52.44   25.51    NO

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    6. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
```

1000.	98.73	6	1.0	1.1	10000.0	21.41	34.17	14.63	NO

****
*** SCREEN DISCRETE DISTANCES ***
****

*** TERRAIN HEIGHT OF 8. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
2500.	54.73	6	1.0	1.1	10000.0	19.41	78.07	24.82	NO

****
*** SCREEN DISCRETE DISTANCES ***
****

*** TERRAIN HEIGHT OF 10. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
5000.	25.22	6	1.0	1.1	10000.0	17.41	145.74	34.49	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 TERRAIN HEIGHTS ENTERED FOR *
* SIMPLE ELEVATED TERRAIN PROCEDURE *
****

TERRAIN HT (M)	DISTANCE RANGE (M) MINIMUM	MAXIMUM
2.	300.	--
4.	500.	--
5.	750.	--
6.	1000.	--
8.	2500.	--
10.	5000.	--

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

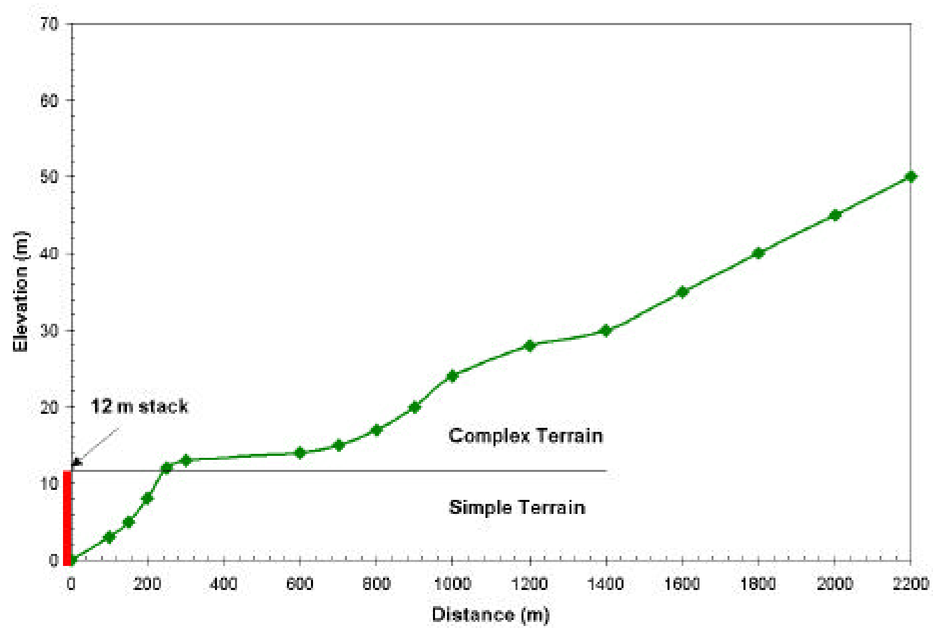
CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	194.4	300.	2.

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

Input Cases:

The following **RECEPTOR/COMPLEX TERRAIN** examples are provided:

Source Parameters	**Case 1**	**Case 2**
Stack height (m)	12	12
Stack diameter (m)	0.30	0.30
Stack gas exit velocity (m/s)	2.5	2.5
Stack gas exit temperature (K)	573	573
SO_2 emission rate (g/s)	0.5	0.5
Meteorology	Full	Full
Ambient Temperature (K)	293	293
Dispersion	Rural	Rural
Receptors	Discrete	Discrete
Terrain	Complex	**Complex and Simple**
Elevation Range: Distance Range	13 to 50 m: 100 to 250 m	**3 to 50 m: 300 to 2200 m**
Input values that have changed from the Base Case (Case 1) are shown in boldface text.		



Interpretation:

Case	**Case 1**	**Case 2**
“VALLEY Model” Complex Predictions		
Maximum 24-h average SO_2 (Valley) ($\mu g/m^3$)	14.52	14.52
Maximum **1-h** average SO_2 (Valley) ($\mu g/m^3$)	58.1	58.1
Downwind distance (m)	300	300
“Simple” Complex Predictions		
Maximum 24-h average SO_2 (Simple) ($\mu g/m^3$)	181.3	181.3
Maximum **1-h** average SO_2 (Simple) ($\mu g/m^3$)	453	453
Downwind distance (m)	300	300
PG Stability Class	D (4)	D (4)
10-m Wind Speed (m/s)	1.0	1.0
Simple Predictions		
Maximum **1-h** average SO_2 ($\mu g/m^3$)	-	**580.2**
Downwind distance (m)	-	**250**
PG Stability Class	-	**D (4)**
10-m Wind Speed (m/s)	-	**1.0**
Mixing Height (m)	-	**320**
Output values that have changed from the Base Case (Case 1) are shown in boldface text.		

The VALLEY Model” 24-h average complex terrain predictions must be multiplied by 4.0 to obtain a 1-h average prediction.

The “Simple” 24-h average predictions must be multiplied by 2.5 to obtain a 1-h average prediction.

Case 1 was run assuming complex terrain.

Case 2 was run assuming the Case 1 complex terrain and for simple terrain.

```
                                                                02/09/02
                                                                14:30:15
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Receptor/Complex Terrain               Case 1

COMPLEX TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HT (M)           =      12.0000
   STACK DIAMETER (M)     =        .3000
   STACK VELOCITY (M/S)   =       2.5000
   STACK GAS TEMP (K)     =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL

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


BUOY. FLUX =     .270 M**4/S**3;  MOM. FLUX =     .072 M**4/S**2.


FINAL STABLE PLUME HEIGHT (M) =   23.4
DISTANCE TO FINAL RISE (M)    =  151.3

                         *VALLEY 24-HR CALCS*   **SIMPLE TERRAIN 24-HR CALCS**
 TERR        MAX 24-HR              PLUME HT            PLUME HT
  HT    DIST    CONC        CONC    ABOVE STK    CONC    ABOVE STK    U10M USTK
 (M)    (M)   (UG/M**3)   (UG/M**3)  BASE (M)  (UG/M**3)  HGT (M)  SC   (M/S)
----- ------- ----------  ----------  ------   ----------  ------   -- ---- ----
  13.    300.  181.3       14.52        23.4    181.3         7.8   4  1.0  1.0
  14.    600.  87.45       10.26        23.4    87.45        15.4   6  1.0  1.1
  15.    700.  83.64       8.660        23.4    83.64        15.4   6  1.0  1.1
  17.    800.  77.79       7.391        23.4    77.79        15.4   6  1.0  1.1
  20.    900.  71.84       6.375        23.4    71.84        15.4   6  1.0  1.1
  24.   1000.  5.554       5.554        23.4    .0000          .0   0   .0   .0
  28.   1200.  4.351       4.351        23.4    .0000          .0   0   .0   .0
  30.   1400.  3.511       3.511        23.4    .0000          .0   0   .0   .0
  35.   1600.  2.901       2.901        23.4    .0000          .0   0   .0   .0
  40.   1800.  2.444       2.444        23.4    .0000          .0   0   .0   .0
  45.   2000.  2.091       2.091        23.4    .0000          .0   0   .0   .0
  50.   2200.  1.825       1.825        23.4    .0000          .0   0   .0   .0

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

 CALCULATION         MAX CONC    DIST TO   TERRAIN
  PROCEDURE         (UG/M**3)    MAX (M)    HT (M)
--------------    -----------    -------   -------
COMPLEX TERRAIN     181.3          300.       13. (24-HR CONC)


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

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```
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Receptor/Complex Terrain               Case 2

COMPLEX TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HT (M)           =      12.0000
   STACK DIAMETER (M)     =        .3000
   STACK VELOCITY (M/S)   =       2.5000
   STACK GAS TEMP (K)     =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL

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


BUOY. FLUX =     .270 M**4/S**3;  MOM. FLUX =     .072 M**4/S**2.


FINAL STABLE PLUME HEIGHT (M) =   23.4
DISTANCE TO FINAL RISE (M)    =  151.3
```

TERR HT (M)	DIST (M)	MAX 24-HR CONC (UG/M**3)	*VALLEY 24-HR CALCS* CONC (UG/M**3)	PLUME HT ABOVE STK BASE (M)	**SIMPLE TERRAIN 24-HR CALCS** CONC (UG/M**3)	PLUME HT ABOVE STK HGT (M)	SC	U10M (M/S)	USTK (M/S)
13.	300.	181.3	14.52	23.4	181.3	7.8	4	1.0	1.0
14.	600.	87.45	10.26	23.4	87.45	15.4	6	1.0	1.1
15.	700.	83.64	8.660	23.4	83.64	15.4	6	1.0	1.1
17.	800.	77.79	7.391	23.4	77.79	15.4	6	1.0	1.1
20.	900.	71.84	6.375	23.4	71.84	15.4	6	1.0	1.1
24.	1000.	5.554	5.554	23.4	.0000	.0	0	.0	.0
28.	1200.	4.351	4.351	23.4	.0000	.0	0	.0	.0
30.	1400.	3.511	3.511	23.4	.0000	.0	0	.0	.0
35.	1600.	2.901	2.901	23.4	.0000	.0	0	.0	.0
40.	1800.	2.444	2.444	23.4	.0000	.0	0	.0	.0
45.	2000.	2.091	2.091	23.4	.0000	.0	0	.0	.0
50.	2200.	1.825	1.825	23.4	.0000	.0	0	.0	.0

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14:34:57

```
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Receptor/Complex Terrain               Case 2

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .500000
   STACK HEIGHT (M)       =      12.0000
   STK INSIDE DIAM (M)    =        .3000
   STK EXIT VELOCITY (M/S)=       2.5000
   STK GAS EXIT TEMP (K)  =     573.0000
   AMBIENT AIR TEMP (K)   =     293.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

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


BUOY. FLUX =     .270 M**4/S**3;  MOM. FLUX =     .072 M**4/S**2.
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*** FULL METEOROLOGY ***

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    3. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   100.   221.3        2     1.0    1.0   320.0   16.91   19.40   10.84    NO

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    5. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   150.   312.4        3     1.0    1.0   320.0   14.87   18.26   11.02    NO

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    8. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   200.   455.1        4     1.0    1.0   320.0   11.80   15.72    8.79    NO

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF   12. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   250.   580.2        4     1.0    1.0   320.0    7.80   19.25   10.56    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 TERRAIN HEIGHTS ENTERED FOR  *
 *    SIMPLE ELEVATED TERRAIN PROCEDURE     *
 ********************************************

      TERRAIN        DISTANCE RANGE (M)
       HT (M)       MINIMUM     MAXIMUM
      -------      --------    --------
           3.         100.         --
           5.         150.         --
           8.         200.         --
          12.         250.         --

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

 CALCULATION        MAX CONC    DIST TO   TERRAIN
```

```
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      580.2          250.       12.

COMPLEX TERRAIN     181.3          300.       13. (24-HR CONC)


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