Risk A
Pollutio

in part

DC

Departmen

Risk Assessment for Selecting Pollution Prevention Alternatives

By

Souad Benromdhane

Volume I

A Ph.D. Dissertation

Submitted to
Michigan State University
in partial fulfillment of the Requirements
for the Degree of

DOCTOR OF PHILOSOPHY

Department of Civil and Environmental Engineering

1998

for Selecting

Manufacturing process emis
and Title V of the Clean Air Act
promulgated by the U.S. Enviro
may be utilized to reduce emissi
the preferred hierarchy for emiss
by treatment. The traditional ap
This approach has been driven b
transfer of pollutants from one m
a solid waste or water pollutant.
are multiplied rather than being

Currently, priorities are bein
involved with treatment solution
technologies have driven industr
are now being used to evaluate th
by different industrial operations
implementation.

The foundry industry, a major
designated as one of the industrie
Control Technology (MACT) pr

ABSTRACT

Risk Assessment for Selecting Pollution Prevention Alternatives

By

Souad Benromdhane

Manufacturing process emissions from foundries are regulated under Title I, Title III, and Title V of the Clean Air Act Amendments (CAAA) and implementing regulations promulgated by the U.S. Environmental Protection Agency (EPA). Several strategies may be utilized to reduce emissions. Under established principles of pollution prevention, the preferred hierarchy for emissions control is : (1) source reduction, (2) recycling, and (3) treatment. The traditional approach to emissions control has focused on treatment. This approach has been driven by the pre-1990 regulatory scheme. This often results in transfer of pollutants from one medium to another, i.e., a collected air pollutant becomes a solid waste or water pollutant. Risks are not reduced but rather are transferred. Costs are multiplied rather than being minimized.

Currently, priorities are being given to a more preventive approach. The costs involved with treatment solutions, waste disposal and management, and control technologies have driven industries to pollution prevention. Risk assessment techniques are now being used to evaluate the impact and risk associated with the hazards generated by different industrial operations to study the feasibility of control options before implementation.

The foundry industry, a major source of hazardous air pollutants (HAPs), has been designated as one of the industries to be regulated under the Maximum Achievable Control Technology (MACT) provisions of Title V of the Clean Air Act. Thus, in

conjunction with representatives from the General Motors Corporation (GM) and the Ford Motor Company, the GM Powertrain Saginaw Malleable Iron Foundry was selected as the site to test the application of a new risk assessment modeling technique.

A four component model of risk assessment is proposed. It involves: 1) identifying and quantifying of the source input; 2) modeling transport to the receptor; 3) evaluating the risks to the receptor; and, 4) assessing the impact of pollution prevention on the source. This last step allows refining the selection of the pollutants of concern and ranking of the pollution prevention alternatives.

One of the important priorities to be addressed in the foundry industry is the emissions of HAPs from the casting process at the pouring cooling and shakeout steps. These emissions result from about 19 different families of resin binders in commercial use. A mass balance approach to the molding operations was selected as the method to estimate some of the HAP emissions. Alternate methods were also explored.

The U.S. Environmental Protection Agency Industrial Source Complex dispersion model (ISC-3) was selected as the transport model. Exposure concentrations and their variability around the facility at the ground level for short term exposure were calculated to estimate the impact on the risk evaluation.

A probabilistic approach as opposed to the "point estimate" approach was undertaken to assess the exposure and toxic effects of the pollutants of concern. A sampling strategy that defines exposure assessment as an inherently statistical problem was made to include randomness and representative situations. This is expected to lead to a better description of the risk, and to establish pollution prevention priorities based on realistic scenarios.

To my parents, who alw

wh

To my parents, who always prayed for my success, in particular, my father who did not live to see this day.

AC

All praises be to All

universe for providing me with

I am appreciative for

through the Manufacturing R

work would not have been acc

I would like to express

L Davis for his continued su

studies. He has been like a fa

committee, Dr. M. Kamrin, D

and suggestions.

I wish to express my

continued prayers, support an

owed to my sister Saida and

come true. I am also gratef

Suhail. They have always

Doctoral degree.

Thanks to all the peopl

this work, namely, Dr. S. S. Fa

M. Jabbur from the Air Force

Last but not least, spec

all their services, in particula

Engineering for their indefinite

ACKNOWLEDGMENTS

بسم الله الرحمان الرحيم

In the Name Of Allah
Most Gracious, Most Merciful

All praises be to Allah Subhanahu-wa-Taala, the creator and sustainer of this universe for providing me with the strength and the patience to complete this work.

I am appreciative for the financial support from Michigan State University, through the Manufacturing Research Consortium. Without this support, this research work would not have been accomplished.

I would like to express my sincere gratitude to my major advisor, Dr. Mackenzie L. Davis for his continued support and guidance throughout the years of my Doctoral studies. He has been like a father to me. I would like also to thank the members of my committee, Dr. M. Kamrin, Dr. S. Masten, and Dr. S. Selke for their valuable criticism and suggestions.

I wish to express my greatest thanks and appreciation to my mother for her continued prayers, support and encouragement. The warmest feelings of gratitude are owed to my sister Saida and her husband Izzat, who stood by me and made this dream come true. I am also grateful to my sister Sonia, my brothers Lassaad, Sofiane and Souheil. They have always prayed for my success and supported my pursuit of this Doctoral degree.

Thanks to all the people who by a means or another, contributed to the success of this work, namely, Dr. S. S. Farinwata from Ford, Mr. J. Touma from EPA, NC., and Mr. M. Jabbur from the Air Force W. DC. for their precious help and availability.

Last but not least, special thanks to all the staff at Michigan State University for all their services, in particular those in the Department of Civil and Environmental Engineering for their indefinite kindness and availability.

Table of Contents

CHAPTER 4 *Mass Balance Model*

CHAPTER 5 *Transport Model*

CHAPTE

CHAPTE

CHAPTE

CHAPTER 6 *Exposure Assessment*

CHAPTER 7 *Toxicity Assessment*

CHAPTER 8 *Risk Characterization*

CHAPTER 9 *Risk Assessment Techniques as a Tool for Selecting Pollution Prevention Alternatives*

CHAPTER 10 *Summary, Conclusions, and Recommendations*

List of Tables

List of Figures

1.1 Background

Risk assessment has been used

groundwater contaminated by

to analyze the existing situatio

scenarios. The major goal of

decisions that are more system

been the case in the past. In a

making estimates of all the sig

failure modes and/or exposure

(Asante-Duah 1993). It provid

of the consequences arising fr

outcome, exposure and conseq

specific responses that will ins

Hypothetical cases and "what

models to evaluate the impact o

pollution prevention techniques

Chapter 1

INTRODUCTION

1.1 Background

Risk assessment has been used as part of the remediation process for cleaning soil and groundwater contaminated by uncontrolled releases of hazardous waste. It has been used to analyze the existing situation and evaluate the health risk of alternative clean-up scenarios. The major goal of the risk assessment is to help develop risk management decisions that are more systematic, more comprehensive and accountable than has often been the case in the past. In a generic sense, risk assessment is a systematic process for making estimates of all the significant risk factors that prevail over an entire range of failure modes and/or exposure scenarios due to the presence of some type of hazard (Asante-Duah 1993). It provides not only a quantitative but also a qualitative evaluation of the consequences arising from the hazard that could initiate a specific response, outcome, exposure and consequence. The process of risk assessment can establish case specific responses that will insure justifiable, defensible, and cost effective decisions. Hypothetical cases and "what if" scenarios can be investigated via risk assessment models to evaluate the impact on human health of not only clean-up approaches but also pollution prevention techniques. In particular, the risk assessment technique can be used

as a tool to assess pollution p
of interest to the industrial co
regulations.

One of the most significant ac
development of organic binde
more complicated cores and m
was developed for other indus
Feazel 1976). Hence, little co
use. For many years, in this i
surface of the casting. As a c
strengthen the cores, which a
error was used to determine t
were overlooked. Only after
be a major source, a major e
toxic chemicals and to deter

This research demonstrates
foundry industry (the case o
an approach to identify the
with the exposure to the haz

as a tool to assess pollution prevention alternatives. The results of this technique will be of interest to the industrial community in facing the challenge of increasingly stringent regulations.

One of the most significant advances in the foundry industry in the last thirty years is the development of organic binders. This class of binders made it possible to manufacture more complicated cores and more dimensionally accurate molds. Often the technology was developed for other industries and updated to metal casting applications (Scott and Feazel 1976). Hence, little consideration was given to the environmental impacts of their use. For many years, in this industry the focus was on how to obtain a better quality surface of the casting. As a consequence, several chemicals were added to the binders to strengthen the cores, which are the most fragile part of the molding assembly. Trial and error was used to determine the best ratios of mixing but for a long time toxic emissions were overlooked. Only after foundry, and in particular the casting process, was found to be a major source, a major effort was undertaken to identify and quantify the release of toxic chemicals and to determine their health impact.

This research demonstrates the use of risk assessment as a pollution prevention tool. The foundry industry (the case of a steel foundry) has been selected as the example for testing an approach to identify the hazard, assess and estimate the human health risk associated with the exposure to the hazard, and evaluate some preventive steps to reduce the emissions at the source. A m

approach for the risk assessm

References

AsanteDuah, K. D. (1993). H.
Scott, W. D. and C. E.
Chemistry. Birmingha

emissions at the source. A major innovation in this research is to use a probabilistic approach for the risk assessment.

References

AsanteDuah, K. D. (1993). Hazardous Waste Risk Assessment. Boca Raton, Florida.
Scott, W. D. and C. E. Feazel (1976). A Review of Organic Sand Binder Chemistry. Birmingham, Alabama, Southern Research Institute.

2.1 Foundry Overv

Although each foundry acc
casting of metal products, s
describes the foundry proce
Malleable Iron Plant which
1917, manufactures and dis
transmission parts for Gene
and Chrysler Corporation.
production quotas.

Malleable iron is produced
added in the form of coke),
melting phase. Malleable ir
Electric induction furnaces (

Chapter 2

Foundry Emissions

2.1 Foundry Overview

Although each foundry accomplishes the same basic tasks as shown in Figure 2.1, the casting of metal products, specific materials, equipment, and processes vary. This chapter describes the foundry process implemented at the General Motors Powertrain Saginaw Malleable Iron Plant which is located in Saginaw, Michigan. The plant, established in 1917, manufactures and distributes finished automotive pieces such as pistons and transmission parts for General Motors Corporation as well as for Ford Motor Company and Chrysler Corporation. It operates 24 hours per day, 5 to 7 days per week to meet production quotas.

Malleable iron is produced by the inoculation of the molten metal with carbon (which is added in the form of coke), and small amounts of silicon and magnesium during the melting phase. Malleable iron treatment also requires annealing of cooled pieces. Electric induction furnaces (EIFs) are used for melting at the Saginaw foundry.

enter a sump and are pumpe

and finally to two drainage c

reenters the plant for reuse. T

feet of foundry sand. Daily

three million gallons of this

obtained from recycled plant

2.1.1 Description of

The plant produces castings

steps: 1) raw materials handl

melting; 4) casting (which in

(which includes annealing, g

step and the major pollutants

2.1.2 Raw Materials

Handling operations include r

for both furnace charging and

railroad cars, trucks and conta

open piles. When needed, the

by similar means.

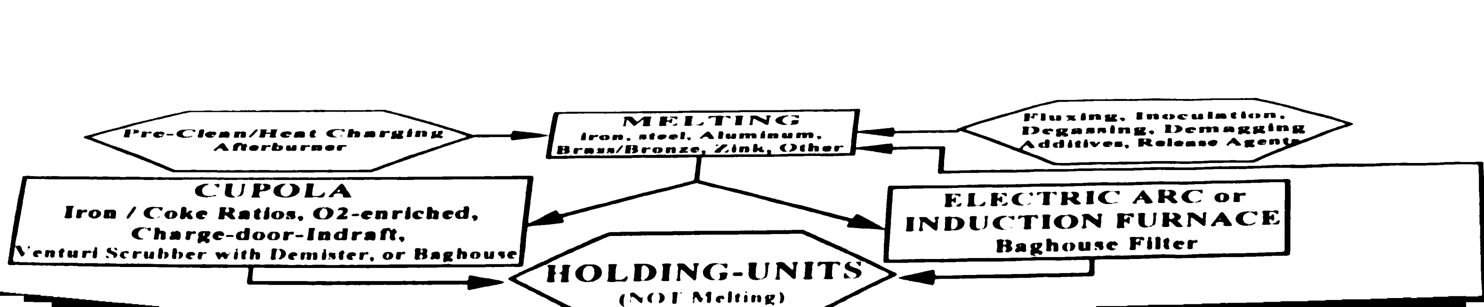
enter a sump and are pumped to a primary lagoon which drains first to a secondary lagoon and finally to two drainage ditches for settling. After settling is complete, the water then renters the plant for reuse. The primary pond is dredged daily of approximately 15 cubic feet of foundry sand. Daily water usage is approximately nine million gallons. Two to three million gallons of this water is purchased from the city. The remaining water is obtained from recycled plant water.

2.1.1 Description of Production Steps

The plant produces castings from 100% recycled scrap. There are five major production steps: 1) raw materials handling and preparation; 2) mold and core production; 3) metal melting; 4) casting (which includes pouring, cooling and shakeout); and 5) finishing (which includes annealing, grinding, and shot blasting). A description of each production step and the major pollutants emitted follows.

2.1.2 Raw Materials Handling, Storage, and Preparation

Handling operations include receiving, unloading, storing and conveying raw materials for both furnace charging and mold and core preparation. Raw materials are received in railroad cars, trucks and containers, then transferred by truck, loaders and conveyors to open piles. When needed, the raw materials are transferred from storage to process areas by similar means.


Pre-Clean/Heat Charging
Afterburner
MELTING
Iron, steel, Aluminum,
Brass/Bronze, Zink, Other
Fluxing, Inoculation,
Degassing, Demagging
Additives, Release Agents
CUPOLA
Iron / Coke Ratios, O2-enriched,
Charge-door-Indraft,
Venturi Scrubber with Demister, or Baghouse
ELECTRIC ARC or
INDUCTION FURNACE
Baghouse Filter
HOLDING-UNITS
(NOT Melting)

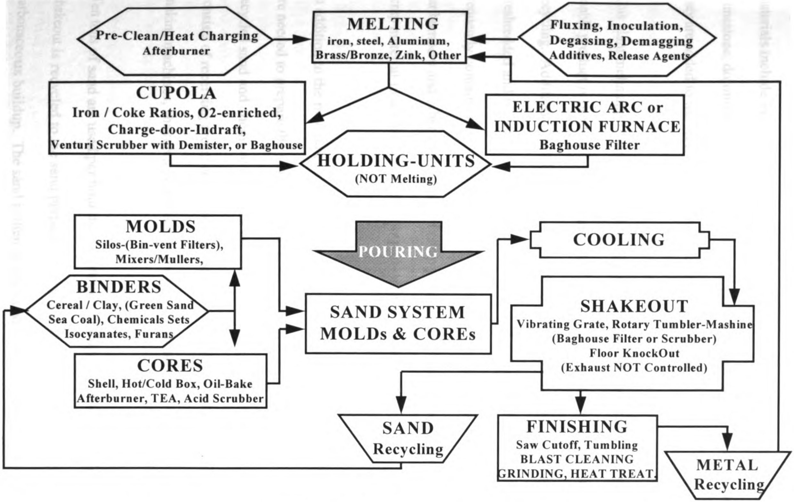


Figure 2.1 Typical Layout of a Foundry.

Metallics and fluxes are the m

materials include iron and stee

limestone, dolomite), fluoride

they are added to the steel to in

This plant melts approximately

usable product is produced. T

recycling. Additional metal s

preshredded and is stored in c

frequently contains zinc, alu

car bumpers and other chron

scrap material in accordance

In addition to the raw mater

are needed to prepare the sa

recycled sand and chemica

consists of receiving areas.

making machines, shakeou

Ten tons of sand are used

shakeout is recycled to the

carbonaceous buildup. Th

plant currently has the ab

Metallics and fluxes are the major materials required for furnace charging. Metallic raw materials include iron and steel scrap and foundry returns. Fluxes include carbonates (limestone, dolomite), fluoride (fluospar), and carbide compounds (calcium carbide), and they are added to the steel to improve the quality of the cast.

This plant melts approximately 1000 tons of iron per day. Close to 500 tons per day of usable product is produced. The remaining 500 tons per day is returned to the furnace for recycling. Additional metal scrap is obtained from various sources. It is delivered preshredded and is stored in open piles in a designated room in the foundry. This scrap frequently contains zinc, aluminum (which does not mix with iron), and chromium (from car bumpers and other chrome-plated scrap pieces). The foundry sets specifications for scrap material in accordance with their part-order specifications.

In addition to the raw materials used to produce the molten metal, a variety of materials are needed to prepare the sand cores and molds that form the iron castings. Lake sand, recycled sand and chemical additives are combined in a sand handling system that consists of receiving areas, conveyors, storage silos, mixers (sand mullers), core and mold making machines, shakeout grates, sand cleaners, and sand screening.

Ten tons of sand are used per hour during normal production. Used sand from castings shakeout is recycled to the sand preparation area and cleaned to remove any clay or carbonaceous buildup. The sand is then screened and reused to make new molds. The plant currently has the ability to reclaim the sand to the quality required for molding, but does not have the technology to

Makeup sand is added to repla

discarded.

Emissions generated during ha

fugitive particulate matter gene

of raw materials. These emissi

2.1.3 Metal Melting

The three most common furna

are cupolas, electric arc, and e

uses four EIFs with a capacity

cylindrical shaped refractory l

with a high frequency alternat

that heats the metal charge in

metal added to the furnace ch

furnace. Any oil or moisture

EIFs are kept closed except w

the furnace allows oxygen to

The basic melting process op

any moisture or oil; (2) furna

does not have the technology to reclaim it to the quality required for core production. Makeup sand is added to replace process losses and contaminated sand that must be discarded.

Emissions generated during handling and preparation of the raw materials include fugitive particulate matter generated from the receiving, unloading, storage and conveying of raw materials. These emissions are currently uncontrolled.

2.1.3 Metal Melting

The three most common furnaces used for metal melting in the gray iron foundry industry are cupolas, electric arc, and electric induction furnaces (EIF). The GM Saginaw Plant uses four EIFs with a capacity of 28 tons of metal per furnace. Each furnace is a cylindrical shaped refractory lined vessel surrounded by electrical coils. When energized with a high frequency alternating current, a fluctuating electromagnetic field is produced that heats the metal charge in approximately 2 minutes. For safety reasons, the scrap metal added to the furnace charge is cleaned and heated before being introduced into the furnace. Any oil or moisture on the scrap metal could cause an explosion in the furnace. EIFs are kept closed except when charging or tapping. A permanent opening in the top of the furnace allows oxygen to enter, and is a continuous source of emissions.

The basic melting process operations are: (1) preheating of the scrap material to evaporate any moisture or oil; (2) furnace charging, in which metal, scrap, alloys, carbon, and flux

are added to the furnace: (3) m
backcharging, which involves
inoculation, during which the
chemical specifications of mall
furnace (which stores the molt
tapping molten metal into a Ro
can hold seven tons of molten

During preheating of the scrap
produced from incomplete con
and scrap on the charge scale.
emitted, but are frequently pla
afterburners can be down any

The highest concentration of f
inoculation, removal, and tapp
released from the melting furn
(CO), organic compounds, sul
quantities of chloride and fluo
melting furnaces come from th
emissions are generated by the
to the charge. The furnace ten

are added to the furnace; (3) melting, during which the furnace remains closed; (4) backcharging, which involves the addition of more metal and alloys as needed; (5) inoculation, during which the carbon, silicon, and magnesium are added to meet the chemical specifications of malleable iron; (6) transfer of molten metal into a ROD furnace (which stores the molten metal and maintains the metal's temperature); and (7) tapping molten metal into a Rotary Motor Iron Pouring Station (RMIPS). Each RMIPS can hold seven tons of molten metal.

During preheating of the scrap metal, particulate matter, chlorides, and fluorides are produced from incomplete combustion of coke, carbon additives, flux additions, and dirt and scrap on the charge scale. Afterburners are installed to decrease the pollutants emitted, but are frequently plugged with sand from the scrap metal. Once plugged, these afterburners can be down anywhere from several days to several months.

The highest concentration of furnace emissions occurs during charging, backcharging, inoculation, removal, and tapping operations when the furnace is open. Emissions released from the melting furnaces include: particulate matter (PM), carbon monoxide (CO), organic compounds, sulfur dioxide (SO_2), nitrogen oxides (NO_x), and small quantities of chloride and fluoride compounds. Fine particulate fumes emitted from the melting furnaces come from the condensation of volatilized metal and metal oxides. CO emissions are generated by the combustion of organic material on scrap and carbon added to the charge. The furnace temperature will also affect the amount of CO emitted.

Hydrocarbon emissions (acrol

from vaporization and partial

charge. Measured emissions o

Table 2.1(Gschwandtner and F

Table 2.1 Induction Furnac

Emissio
SiO_2
ZnO
Al_2O_3
Cr_2O_3
CaO
MnO
MoO
TiO
NiO
B_2O_3
PbO
SnO_2
Bi_2O_3
V_2O_5
CuO
CoO
BaO

mg = m

Hydrocarbon emissions (acrolein, benzene, formaldehyde, phenol, toluene, xylene) come from vaporization and partial combustion of any oil remaining on the scrap iron used as a charge. Measured emissions of inorganics from melting operations are summarized in Table 2.1(Gschwandtner and Fairchild 1990).

Table 2.1 Induction Furnace Emissions for Malleable Iron Iron (Gschwandtner and Fairchild 1990).

Emission	mg of contaminant/Mg of metal melted
SiO_2	6.5×10^4
ZnO	5.2×10^4
Al_2O_3	2.6×10^4
Cr_2O_3	1.3×10^3
CaO	6.5×10^2
MnO	1.3×10^3
MoO	2.6×10^2
TiO	1.3×10^2
NiO	1.3×10^2
B_2O_3	2.6×10^1
PbO	1.3×10^1
SnO_2	2.6
Bi_2O_3	2.6
V_2O_5	7.8
CuO	1.3
CoO	2.6
BaO	2.6

mg = milligram, Mg = megagram (1000Kg)

These emissions are dependen

(cold charge or continuous), th

Sources of contamination may

i.e. oil and fuel breakdown p

carbon or graphite or other add

contained in zinc die castings.

plating (i.e., chromium, alumin

Controls for fugitive furnace e

Canopy hoods or special hood

route them to pollution control

2.1.4 Mold and Core

Molds are forms used to shap

mixture of wet sand, clay and

green-sand mold, the most co

Plant, uses moist sand mixed

mixture has a 4 to 5 percent w

volatility bituminous coal) is

expansion when the hot metal

Potential organic substitutes f

organic matter.

These emissions are dependent on the charge material composition, the melting method (cold charge or continuous), the melting rate, and the purity of the materials used. Sources of contamination may include paint on the scrap, various deposits on the scrap (i.e., oil and fuel breakdown products), molding materials adhering to foundry returns, carbon or graphite or other additions in powder form, zinc on galvanized scrap or contained in zinc die castings, and iron and steel scrap containing nonferrous alloys or plating (i.e., chromium, aluminum).

Controls for fugitive furnace emissions include updraft ventilation to a wet scrubber. Canopy hoods or special hoods near the furnace doors and taps capture emissions and route them to pollution control equipment.

2.1.4 Mold and Core Production

Molds are forms used to shape the exterior of the castings. They are prepared using a mixture of wet sand, clay and organic additives. They are usually dried with hot air. The green-sand mold, the most common type, and the one used at the Saginaw Malleable Iron Plant, uses moist sand mixed with 4 to 6 percent clay (bentonite) for bonding. The mixture has a 4 to 5 percent water content. About 5 percent sea coal (a pulverized high volatility bituminous coal) is added to the mixture to prevent casting defects from sand expansion when the hot metal is poured. This makes the lake sand a dark gray color. Potential organic substitutes for sea coal include wood flour, oat hulls, pitch or similar organic matter.

Cores are molded sand shapes

by mixing sand (mulling) with

core. Unlike the green sand m

(Carey, 1990). Resins are ma

tightly together until the iron is

released.

Two core making processes ar

- **Hot-box core**: The sa
phosphoric acid activ
205 to 315 °C for 0.5
typical for furan bind
Gschwandtner and Fa
- **Cold-box core**: The
resins, activated by a
gassed with polyisoc
gas is injected as a ca
(Carey 1986; Gschw

Each of these processes is contr

ratio of binders and resins. Sev

humidity, the size and number o

equipment.

Cores are molded sand shapes used to make the internal voids in castings. They are made by mixing sand (mulling) with organic binders and resins and molding the sand into a core. Unlike the green sand molding process, cores are chemically bonded by resins (Carey, 1990). Resins are made to withstand heat so that the sand particles are held tightly together until the iron is shaped. The resin then decomposes and gases are released.

Two core making processes are used at the Saginaw Malleable Iron Foundry:

- **Hot-box core**: The sand binder is typically 3 to 5 percent furan resin with a phosphoric acid activator. It is cured as a solid core in a heated metal pattern at 205 to 315 °C for 0.5 to 1.5 minutes. SO_2 gas is injected as a catalyst (this is typical for furan binder use). The catalyst induces rapid cure (Carey 1986; Gschwandtner and Fairchild 1990); and
- **Cold-box core**: The sand binder is typically 1 to 3 percent of each of two resins, activated by a nitrogen diluted gas. It hardens when the green core is gassed with polyisocyanate. It is cured for 10 to 30 seconds. Triethylamine gas is injected as a catalyst (this is typical for phenolic isocyanate binder use) (Carey 1986; Gschwandtner and Fairchild 1990).

Each of these processes is controlled by a computer that insures the mixing of the proper ratio of binders and resins. Several binders and resins are used due to variations in humidity, the size and number of cores or molds required, production rates, and equipment.

The organic binders undergo t

temperatures of castings (typic

likely that pyrolysis of the che

radicals which will recombine

widely differing concentrations

On a mass basis, the major pol

particulate matter. Emissions

toluene, xylene) begin with th

open containers of binder mat

and binders. Emissions contin

Organic compounds (acrolein,

monoxide and particulates are

from mold drying.

2.1.5 Pouring, Coolin

A seven ton charge of molten

station. This station is a mech

pouring station where it is lad

control check on the metal tem

a mold. Ventilation is provide

The organic binders undergo thermal decomposition when exposed to the very high temperatures of castings (typically 1400 °C for iron castings). At these temperatures it is likely that pyrolysis of the chemical binder will produce a complex mixture of free radicals which will recombine to form a wide range of chemical compounds that have widely differing concentrations.

On a mass basis, the major pollutant emitted in mold and core production operations is particulate matter. Emissions of Volatile Organic Compounds (i.e., acrolein, benzene, toluene, xylene) begin with their initial exposure to the atmosphere. This occurs from open containers of binder material, the addition of binders to sand, and the mixing of sand and binders. Emissions continue during mold preparation, storage, pouring, and cooling. Organic compounds (acrolein, benzene, formaldehyde, phenol, toluene, xylene), carbon monoxide and particulates are emitted from core baking, and organic emissions result from mold drying.

2.1.5 Pouring, Cooling, and Shakeout

A seven ton charge of molten iron is poured into a rotary motor iron pouring (RMIP) station. This station is a mechanical conveyor that transports the molten iron to the pouring station where it is ladled into molds. Immediately after pouring, a manual quality control check on the metal temperature and composition is made by inserting a probe into a mold. Ventilation is provided in this area and the air is directed to a wet scrubber. The cooling molds are then mech...

circulate on an open conveyor

Shakeout is the process of sep
the castings have solidified, th
vibrating grid. Sand from the
dropped into the basement. P
pieces (with small amounts of
they circulate and cool under a
cooling is covered, but open o
the mold making station by ele
piles for disposal in a Type III

2.1.6 Pollutants of Co

Emissions generated from the r
of hot metal fumes, carbon mo
the mold and core materials co
However, the pouring station e
directed to a wet scrubber. CO
concentration has been measure
hydrocarbons are emitted durin
(Gschwandtner and Fairchild 19

cooling molds are then mechanically conveyed (partially covered) to an enclosed room to circulate on an open conveyor until the casting solidifies in the mold.

Shakeout is the process of separating the casting from the sand molds and cores. After the castings have solidified, they are separated from the cores and molds by means of a vibrating grid. Sand from the mold, the core, and the piece (which is still hot) are dropped into the basement. Pieces are retrieved and collected in a hopper. The hot metal pieces (with small amounts of sand still attached) are then conveyed to the rooftop where they circulate and cool under ambient conditions. The roof area designated for piece cooling is covered, but open on the sides. The sand which can be recycled is returned to the mold making station by elevator. Waste sand is transferred outside to open storage piles for disposal in a Type III landfill.

2.1.6 Pollutants of Concern in the Casting Operations

Emissions generated from the rotary pouring station, RMIP, transfer and pouring consist of hot metal fumes, carbon monoxide, organic compounds and particulates released from the mold and core materials contacting the molten iron. The RMIP is not enclosed. However, the pouring station emissions are collected by upward ventilation and are directed to a wet scrubber. CO emissions peak during pouring and shakeout (the highest concentration has been measured during pouring). The highest concentrations of hydrocarbons are emitted during shakeout, but also peak during the pouring (Gschwandtner and Fairchild 1990). Emissions continue as the molds cool.

During pouring, 95% of the p
diameter and during shakeout
(Scott and Bates 1976). Orga
are expected to sorb to the par

Particulate matter emissions fr
emissions typically contain: ca
sand, silica fines and clay from
present in the molds. During s
sand near the metal and the me
Any VOCs in the sand will con
Table 2.2).

2.1.7 Finishing

After the piece has cooled on th
separate annealing processes ar
and Armasteel Annealing. The
piece in a kiln, allowing the piec
Smaller pieces undergo the Arm
in a kiln at 760 °C for 10 hours.
reheating it in a draw furnace at 5

During pouring, 95% of the particulate matter (PM) emissions are less than 5 microns in diameter and during shakeout 50% of PM emissions are less than 5 microns in diameter (Scott and Bates 1976). Organic compounds contained in the mold and the core materials are expected to sorb to the particulate matter.

Particulate matter emissions from green sand molds peak during shakeout. These emissions typically contain: carbonaceous material from burning organic matter in the sand, silica fines and clay from the molding aggregate, metallic fumes, and other fines present in the molds. During shakeout, a peak of organic emissions is observed when hot sand near the metal and the metal, itself, contact cooler sand containing residual organics. Any VOCs in the sand will continue to volatilize during the sand reclaiming process (see Table 2.2).

2.1.7 Finishing

After the piece has cooled on the roof, it is conveyed to the kiln for annealing. Two separate annealing processes are utilized, depending on the piece: Malleable Annealing and Armasteel Annealing. The first process involves heat treating of the cooled metal piece in a kiln, allowing the piece to slowly cool, a final heat treatment and slow cooling. Smaller pieces undergo the Armasteel annealing process which entails heating the pieces in a kiln at 760 °C for 10 hours, quick-cooling via oil quench for 60-70 seconds and then reheating it in a draw furnace at 540 °C for 2 to 5 hours.

Table 2.2 Some Foundry
Making. Castin
McKenley. Jef

PROCESS	BINDE
Hot-box	Formal Phenol Urea Furfur
Cold-box (amine-gassed)	Carbo Trieth Dimet Methy
	Phen Resin (i.e. t isoph
	Naph

Table 2.2 Some Foundry-Atmosphere Contaminants Evolved During Mold and Core Making, Casting, and Cooling (Gschwandtner and Fairchild 1990; McKenley, Jefcoat et al. 1990).

PROCESS	BINDER INGREDIENTS	POTENTIAL EMISSIONS
Hot-box	Formaldehyde	Aromatic hydrocarbons
	Phenol	Phenol and homologues
	Urea	Ammonia
	Furfuryl alcohol	Chlorinated hydrocarbons
		Hydrogen cyanide
Cold-box (amine-gassed)	Carbon-dioxide	Hydrogen cyanide
	Triethylamine	Phenol and homologues
	Dimethylethylamine	Aromatic hydrocarbons
	Methyl Di-Isocyanite (MDI)	Aniline and homologues (i.e. aniline, toluidine)
	Phenol	Aliphatic amines
	Resin solvents (i.e. trimethyl benzene, isophorone)	Resin solvents (i.e. trimethyl benzene, isophorone) Isocyanates (i.e. methyl, phenyl isocyanate)
	Naphthalene and homologues	Benzoquinolines

After annealing, the pieces ar

on the piece and surface imp

shot-blasting. Large imperfe

imperfections are removed vi

may be required to create det

The finishig operations area h

Finishing operations emit larg

uncontrolled. Emission factor

available.

2.1.8 Waste Handling

Wastes consist of core butts (u

and other process materials. W

the plant into open storage pil

these piles. Slag which is gen

manually scraped from the lad

outside and dumped in open pi

which is located at another GM

with luggers to stop further em

After annealing, the pieces are sent to final finishing, and for removal of sand remaining on the piece and surface imperfections occurring during the casting. Sand is removed by shot-blasting. Large imperfections are removed manually with hammers and smaller imperfections are removed via grinding. Depending on the piece specifications, stamping may be required to create details (holes) in the piece which cannot be produced by cores.

The finishig operations area has been identified as a major source of fugitive emissions. Finishing operations emit large course particles. These emissions are currently uncontrolled. Emission factors for surface cleaning and finishing are not currently available.

2.1.8 Waste Handling and Storage

Wastes consist of core butts (unused cores), unrecyclable sand, slag, contaminated coke, and other process materials. Wastes are transported by vehicle and batch-dumped outside the plant into open storage piles. Visible particulate matter and odors are emitted from these piles. Slag which is generated in the melting process is extremely hot. The slag is manually scraped from the ladles in between usage. It is not quenched, but transported outside and dumped in open piles for cooling. It is then disposed of in a Type III landfill which is located at another GM foundry. The foundry is considering replacing open piles with luggers to stop further emissions and odor problems.

2.2 Hazardous Air P

Hazardous air pollutants (H.

organics, and volatile organi

group of HAPs in the foundr

- Metals
- Semivolatile orga
- Volatile organics

Antimony (Sb), arsenic (As).

account for approximately 9

an iron foundry include: bery

selenium (Se). Major volatile

methanol, methyl di-isocyanat

and vinyl acetate. Typical sem

naphthalene, and various poly

1995).

2.2.1 Binders: Major

Three main classes of resin bin

1995). Depending on variation

2.2 Hazardous Air Pollutant Emissions From Foundries

Hazardous air pollutants (HAPs) can be divided into three groups: metals, semivolatile organics, and volatile organics. According to Euvrard 1992, the contributions of each group of HAPs in the foundry are (Euvrard and Jackson 1992):

- Metals 70% of HAPs
- Semivolatile organics 1%
- Volatile organics 9%

Antimony (Sb), arsenic (As), chromium (Cr), lead (Pb), manganese (Mn), and nickel (Ni) account for approximately 99.8% of the metal HAPs. Other metal HAPs less common in an iron foundry include: beryllium (Be), cadmium (Cd), cobalt (Co), mercury (Hg), selenium (Se). Major volatile HAPs to be controlled include benzene, formaldehyde, methanol, methyl di-isocyanate MDI, triethylamine, tetrachlorethane, toluene, xylenes, and vinyl acetate. Typical semivolatile HAPs include phthalates, phenols, cresols, naphthalene, and various polyaromatic hydrocarbons (PAHs) in trace amounts (Mosher, 1995).

2.2.1 Binders: Major Source of Hazardous Air Pollutants

Three main classes of resin binder systems are used in core and mold (AFS and Association 1995). Depending on variations in humidity, size and number of cores or molds required, production rates, and equipm

nobake or cold-box system (

categorize sand binder syste

"inorganic." Table 2.3 lists

industry. The clays and cem

binders have gradually gaine

phosphate binders have beco

About 19 families of resins a

organic binders are the origi

present as exclusive blends a

finished core or mold produ

as their composition (Bates

Emissions of volatile organ

and the process used. The h

are mostly encountered in p

1999). The second group o

This minimizes the emissio

during metal pouring includ

production rates, and equipment, one of the 3 systems may be used: the heat-activated , nobake or cold-box system (Scott and Feazel 1976; Carey 1990). Another way to categorize sand binder systems is by the elementary classification of "organic" and "inorganic." Table 2.3 lists the sand binder systems typically used in the foundry industry. The clays and cements are the traditional water-plasticized binders. The silicate binders have gradually gained acceptance, especially in the steel foundry. Recently, phosphate binders have become commercially available.

About 19 families of resins are in commercial use (McKenley, Jefcoat et al. 1990). The organic binders are the origin of the hazadous air pollutants emissions. These may be present as exclusive blends and mixtures formulated to achieve desired properties in the finished core or mold production. The method of making and curing them is as important as their composition (Bates and Scott 1975; Scott and Feazel 1976; Carey 1990).

Emissions of volatile organic compounds depend on the composition of the resin binder and the process used. The heat-activated binder systems yield phenol emissions. These are mostly encountered in phenolic hot-box and shell processes (McKenley, Jefcoat et al. 1990). The second group of binder systems (no-bake) are cured at room temperature. This minimizes the emissions during sand preparation. Potential emissions that occur during metal pouring include benzene, formaldhyde, toluene, xylene, and phenol.

Table 2.3 List of the Major

Feazel 1976; Carey 1990)

I. INORGANIC

- A. Clays
  - 1. Bentonite
  - 2. Fire Clay
- B. Cements
- C. Silicates
  - 1. Ethyl Sili
  - 2. Sodium S
    - a. Gassed
    - b. Ungass
- D. Phosphates

II. ORGANIC

- A. Oils
  - 1. Core Oils
  - 2. Oil-Oxyge
- B. Urethane - No-Ba
  - 1. Alkyl Isocy
  - 2. Phenolic Is
    - a. Gassed
    - b. Ungasse
  - 3. Polyester U
- C. Hot-Box
  - 1. Urea-Form
  - 2. Phenolic -F
    - a. Novolac
    - b. Resole
  - 3. Furan
    - a. UF FA
    - b. PF FA
    - c. PF UF
  - 4. Modified
- D. Acid No-Bake
  - 1. Furan
    - a. H_3PO_4
    - b. TSA
    - c. BSA
  - 2. Phenol-F
- E. Starches and Su

Table 2.3 List of the Major Sand Binder Systems Used in the Foundry Industry (Scott and Feazel 1976; Carey 1990)

I. INORGANIC

- A. Clays
  1. Bentonites
  2. Fire Clays
- B. Cements
- C. Silicates
  1. Ethyl Silicate
  2. Sodium Silicate
     - a. Gassed - CO_2
     - b. Ungassed (organic, or inorganic)
- D. Phosphates

II. ORGANIC

- A. Oils
  1. Core Oils
  2. Oil-Oxygen No-Bake
- B. Urethane - No-Bake
  1. Alkyl Isocyanate
  2. Phenolic Isocyanate
     - a. Gassed
     - b. Ungassed
  3. Polyester Urethane
- C. Hot-Box
  1. Urea-Formaldehyde
  2. Phenolic -Formaldehyde
     - a. Novolac
     - b. Resole
  3. Furan
     - a. UF/FA (Urea-Formaldehyde/Furfuryl Alcohol)
     - b. PF/FA (Phenol-Formaldehyde/Furfuryl Alcohol)
     - c. PF/UF (Phenol-Formaldehyde/ Urea-Formaldehyde)
  4. Modified
- D. Acid No-Bake
  1. Furan
     - a. H_3PO_4
     - b. TSA (Toluenesulfonic Acid)
     - c. BSA (Benzenesulfonic Acid)
  2. Phenol-Formaldehyde
- E. Starches and Sugars

2.2.2 Organic Resin

According to the studies of

Alkyl and Phenolic Isocyan

no-bake molds) are formula

to form the rigid urethane re

1975; Scott and Feazel 1976

ROH + R'

Where

R= - in the alkyl sy
glyceride that
group see exam
- in the phenol
solvent see the

R'= is a hydrogen

X= is either a hyd

Figure 2.2 Hypoth

The polyisocyanate will be

will have the general formu

2.2.2 Organic Resin Binders Chemistry

According to the studies of Scott, Bates and others, the no-bake resins (for example, Alkyl and Phenolic Isocyanate resins which are primarily used in foundries for cores and no-bake molds) are formulated to contain hydroxyl groups that react with a polycyanate to form the rigid urethane resin film that holds the sand particles in place (Bates and Scott 1975; Scott and Feazel 1976). The basic reaction is:

$$ROH + R'NCO \xrightarrow{\text{catalyst}} R-O-\overset{O}{\overset{\|}{C}}-\overset{H}{\overset{\|}{N}}-R'$$

Where

R=	- in the alkyl system is a long chain compound such as a synthethetic glyceride that contains a fatty acid component with an aliphatic hydroxyl group see example in Figure 2.2 - in the phenolic urethane is a phenolic resin, usually dissolved in an organic solvent see the example in Figure 2.3
R'=	is a hydrogen or a substituent group
X=	is either a hydrogen or CH_2OH

$$CH_2O\overset{O}{\overset{\|}{C}}(CH_2)_7\ CH = CHCH_2CH = CH\ (CH_2)_4CH_3$$
$$|$$
$$CH\ O\overset{O}{\overset{\|}{C}}(CH_2)_7\ CH = CHCH_2CH = CH\ (CH_2)_4CH_3$$
$$|$$
$$CH_2O\overset{O}{\overset{\|}{C}}(CH_2)_7\ CH = CHCH_2\ \underset{OH}{\underset{|}{C}}\ HCH_2(CH_2)_4CH_3$$

Figure 2.2 Hypothetical structure containing ricinoleic acid in castor oil

The polyisocyanate will be the same for either of the Alkyl and Phenolic systems, and will have the general formula in Figure 2.4.

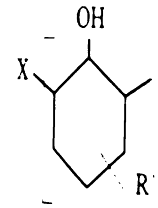


Figure 2.3. An example of t[illegible]
1975; Scott and Feazel 197[illegible]

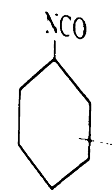


Figure 2.4. General Formula f[illegible]
Scott and Feazel 1976)

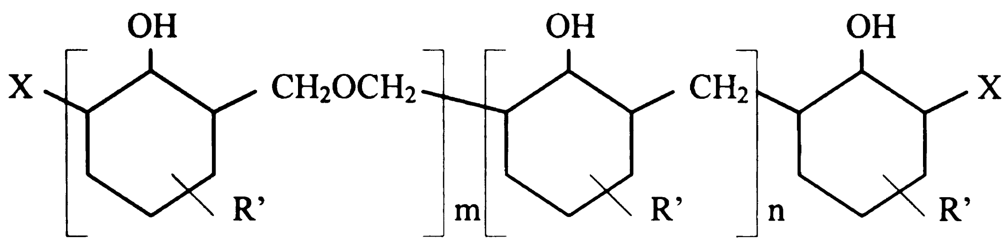


Figure 2.3. An example of the phenolic resin (R) in a phenolic system (Bates and Scott 1975; Scott and Feazel 1976)

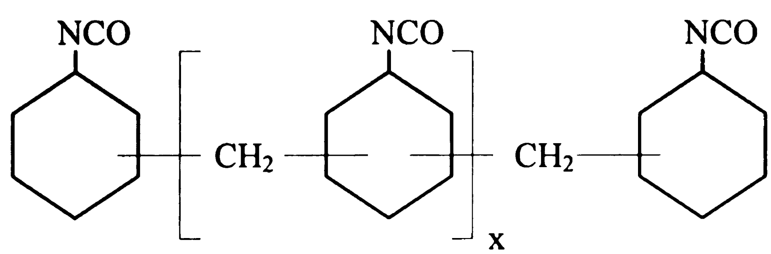


Figure 2.4. General Formula for Polyisocyanate for both systems (Bates and Scott 1975; Scott and Feazel 1976)

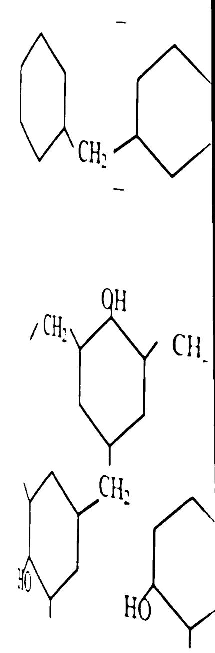
The shell and furan hot-bo

polymerization. The shell

create the phenolic polyme

sand in the form of hexame

ammonia and formaldehyde



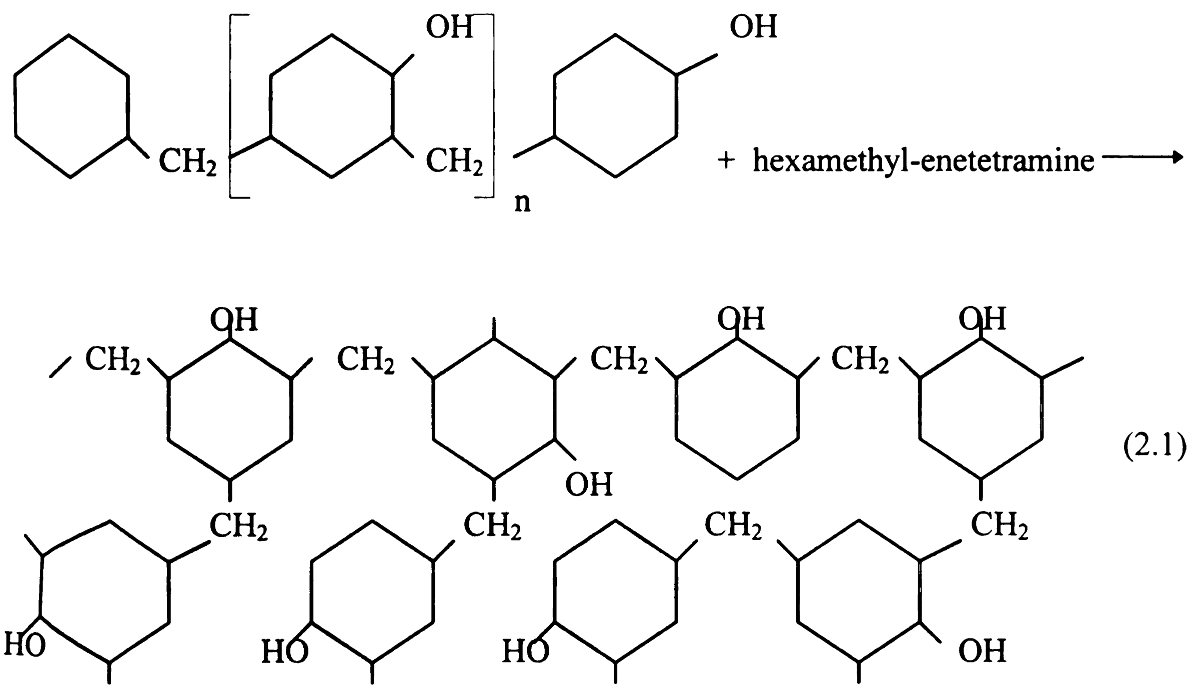
The hot-box furan resin under

no other reactants. The reacti

between the rings and water is

The reaction is:

The shell and furan hot-box binders, on the other hand, were found to require heat for polymerization. The shell sand binder uses a novalac resin that requires formaldehyde to create the phenolic polymer that binds the sand. This binder component is added to the sand in the form of hexamethylenetetramine, an organic compound that decomposes into ammonia and formaldehyde when heated. The binder reaction is :



(2.1)

The hot-box furan resin undergoes a similar polymerization, although this resin requires no other reactants. The reaction is one of condensation as methylene bridges from between the rings and water is released (Bates and Scott 1975; Scott and Feazel 1976). The reaction is:

This polymer product form

prepolymer, urea is often a

contain urea formaldehyde

2.2.3 Binder Resin

Each of these organic bind

interface (Bates 1975). Pyr

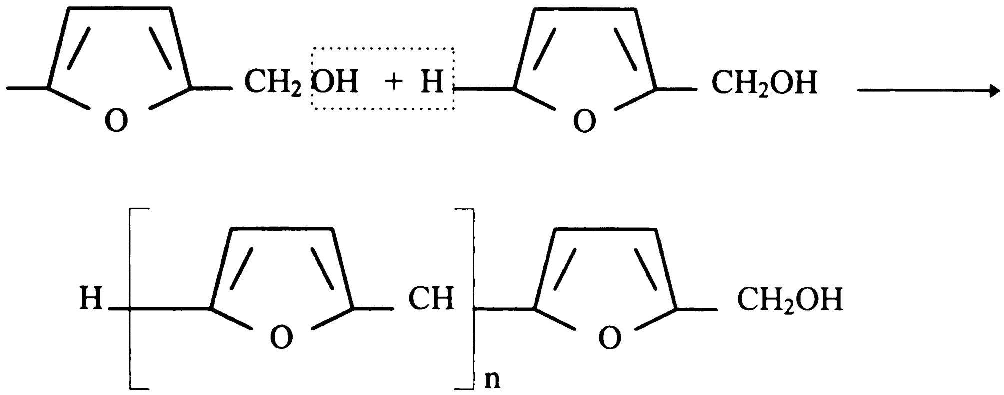
cast. The high temperature

are poured and form volati

methane, ethane, ethylene, a

produce aromatic hydrocarb

Feazel 1976; Carey 1986).



(2.2)

This polymer product forms the rigid film that bonds the sand grains. In making the furan prepolymer, urea is often added to the furfuryl alcohol and the resulting binder may contain urea formaldehyde polymers (Bates and Scott 1975; Scott and Feazel 1976).

2.2.3 Binder Resin Decomposition

Each of these organic binders can be expected to behave similarly at the mold-metal interface (Bates 1975). Pyrolysis is expected to be nearly complete at the surface of the cast. The high temperature will thermally decompose the resin compounds when castings are poured and form volatile compounds such as carbon monoxide, carbon dioxide, methane, ethane, ethylene, acetylene and hydrogen. The phenolic portion is expected to produce aromatic hydrocarbons (Bates and Scott 1975; Scott and Bates 1975; Scott and Feazel 1976; Carey 1986).

2.2.4 Measured HAPs

During a foundry emission

Maysilles 1993). A good

decomposition effluent is p

In their work, castings were

foundry binders in an exper

by an exhaust hood. Sampl

stack method, which is a rec

reference gives an experime

from molds during the one-

hour was calculated based o

include emissions at the mo

emissions and are considere

pouring, cooling and shake

Kielty, and Trenholm, prov

Cowherd 1979). They revi

emission factors. In anothe

values for emissions of iso

1986). Klafka and Loeffler

actual foundries (Klafka an

2.2.4 Measured HAPs from Molding and Core Making Process

During a foundry emissions data review, Maysilles identified several useful references (Maysilles 1993). A good source for measured concentrations of chemicals from mold decomposition effluent is provided by Scott, Bates and James (Scott, Bates et al. 1977). In their work, castings were poured into prepared commercial formulations of selected foundry binders in an experimental foundry and were covered immediately after pouring by an exhaust hood. Sampling and analysis procedures used are referred to as a quasi-stack method, which is a recognized technique to identify point source emissions. This reference gives an experimental description of a laboratory study of organic emissions from molds during the one-hour period immediately after pouring. An average over one hour was calculated based on the quantity of metal poured. These measurements did not include emissions at the mold preparation and pouring. The data are useful for estimating emissions and are considered in many other papers (Maysilles 1993). The data for pouring, cooling and shakeout are summarized in Table 2.4. Wallace, et al, Quarles, Kielty, and Trenholm, provided estimates of uncontrolled emissions (Wallace and Cowherd 1979). They reviewed many test reports to present a complete range of emission factors. In another laboratory study, Renman, Sango, and Skarping determined values for emissions of isocyanate and amines from polyurethane (Renman, Sangö et al. 1986). Klafka and Loeffler presented data on benzene and formaldehyde emissions in actual foundries (Klafka and Loeffler 1995).

TABLE 2.4 Foundry Emission Data (lb/ton of iron). (Maysilles, 1993)

TABLE 2.4 Foundry Emission Data (lb/ton of iron). (Maysilles, 1993)

Pouring Emission Source		Cooling Emission Source						Shakeout Emission Source	
		HAP	green sand	furan hot-box binder system	phenolic hot-box binder system	alkyd isocyanate cold-box binder system	phenolic urethane cold-box binder system		
HAP	Emissions	hydrogen cyanide	1.2E-01	3.3E-01	1.2E-01	1.4E-02	7.2E-02	HAP	Emissions
particulate	4.2	formaldehyde	6.0E-04	9.0E-04	6.0E-04	8.7E-03	1.5E-03	particulates	1.4E+01
benzene	1.0E-01	acrolien	3.0E-04	1.2E-03	9.0E-04	7.2E-03	2.1E-03	TOC	1.2E+00
toluene	1.7E-02	aldehydes C2-C4	9.0E-03	1.2E-03	2.7E-02	1.8E-01	8.4E-03	naphthalene	1.0E-02
xylene	6.1E-02	benzene	8.7E-02	5.1E-02	9.9E-02	4.4E-01	3.7E-01	cadmium	4.6E-03
TOC	1.3	toluene	9.0E-03	2.7E-03	1.8E-02	1.3E-01	5.7E-02	chromium	5.2E-04
MDI	3.1E-03	xylenes	3.0E-04	3.6E-03	1.5E-02	5.2E-01	3.9E-02	manganese	2.2E-04
MBA	3.6E-03	naphthalene	1.9E-03	1.8E-03	1.8E-03	3.0E-03	3.0E-04		
Phenol	1.0E-01	phenol	1.8E-02	1.8E-03	1.1E-02	9.0E-03	2.7E-01		

For the case study, ana

bases for the risk asses

2.2.5 Estimated H.

Several attempts have

mold and core making

concentrations of diffe

Scott 1975; Mosher 19

Air Emissions Species

in special reports comm

1980), and Hamilton Co

Emissions of volatile o

and the process used. T.

variety of binders used i

phenol emission. These a

McKenley, Jefcoat et al.

at room temperature. Th

2.2.6 Data Used in th

For our case study, analys

were acquired for real data

represented in Table 2.6.

For the case study, analysis results of the binders used in the foundry were acquired as the bases for the risk assessment. The measured emission factors are represented in Table 2.5.

2.2.5 Estimated HAPs from Molding and Core Making Process

Several attempts have been made to estimate hazardous air pollutant emissions from mold and core making operations. Mosher, for example, provided extrapolated concentrations of different constituents of effluent from mold decomposition (Bates and Scott 1975; Mosher 1994). Mosher used the information on HAP emissions found in the Air Emissions Species Manual Volume I, Volatile Organic Compound Species Profiles or in special reports commissioned by the EPA (U.S.EPA and Research Triangle Park 1980), and Hamilton County, Tennessee (Bernard 1990).

Emissions of volatile organic compounds depend on the composition of the resin binder and the process used. Table 2.5 lists potential emissions from the casting operations for a variety of binders used in the foundry industry. The heat-activated binder systems yield a phenol emission. These are mostly encountered in phenolic hot-box and shell processes (McKenley, Jefcoat et al. 1990). The second group of binder systems (nobake) are cured at room temperature. This minimizes the emissions during sand preparation.

2.2.6 Data Used in the Transport Model

For our case study, analysis results of the emissions from the binders used in the foundry were acquired for real data considerations. The measured emission factors are represented in Table 2.6.

Table 2.5 Selected binder HAP emission factors (Maysilles 1993; Mosher 1994)

Type Mold/ Core-Binder-->	Phenolic NoBake	Phenolic Urethane	Phenolic HotBox	Green Sand	Core Oil	Shell	Nitroge n Furan	Nitrogen Furan-	Furan HotBox	Alkyd Isocyanate	Sodium Silicate-

Table 2.5 Selected binder HAP emission factors (Maysilles 1993; Mosher 1994)

Type Mold/ Core-Binder-->	Phenolic NoBake	Phenolic Urethane	Phenolic HotBox	Green Sand	Core Oil	Shell	Nitrogen Furan	Nitrogen Furan-TSA	Furan HotBox	Alkyd Isocyanate	Sodium Silicate-Ester
Type	Resin	Resin	Resin	Seacoal	Core Oil	Resin	Resin	TSA Catalyst.	Resin	Resin+Isocy.	Sugar+Ester
Acrolein	0.000005	0.000031	0.000009	0.000002	0.000077	0.000047	0.000028	0.000016	0.000013	0.000088	0.000028
Benzene	0.011209	0.005351	0.001002	0.000611	0.002344	0.006667	0.000648	0.004534	0.000537	0.005336	0.00141
Formaldehyde	0.00001	0.000022	0.000006	0.000004	0.000096	0.000035	0.000267	0.000065	0.000009	0.000106	0.000169
Hydrogen Cyanide	0.000029	0.001053	0.001184	0.000118	0.000086	0.010526	0.000368	0.000607	0.003474	0.000175	0.000179
M-Xylene	0.000097	0.000439	0.000121	0.000021	0.000239	0.000585	0.002227	0.000243	0.000032	0.002522	0.000094
Naphthalene	0.000049	0.000022	0.00003	0.000021	0.000048	0.000058	0.00004	0.00004	0.000032	0.000037	0.000005
O-Xylene	0.000049	0.000132	0.00003	0.000021	0.000287	0.000117	0.000729	0.00004	0.000032	0.003838	0.000094
Phenol	0.000975	0.003904	0.000203	0.000131	0.000057	0.002456	0.000024	0.000101	0.000016	0.00011	0.000273
Toluene	0.000634	0.000833	0.000182	0.000063	0.000478	0.002807	0.000121	0.008826	0.000032	0.001535	0.000282

Emission Factors are Wt./ Wt.(i.e. lb-Contaminant/ lb-INDEX)

Table 2.6 Measured data of HAP emissions from the casting process provided by GM

Chemicals	SARA	HAP	Total Emission Factors		Pouring		Cooling		Shakeout	
			Lb/Ton Iron	Lb/ Lb Part	Lb/Ton Iron	Lb/ Lb	Lb/Ton Iron	Lb/ Lb	Lb/Ton	Lb/ Lb

Table 2.6 Measured data of HAP emissions from the casting process provided by GM

			Total Emission Factors		Pouring		Cooling		Shakeout	
Chemicals	SARA	HAP	Lb/Ton Iron	Lb/ Lb Part 1 Resin	Lb/Ton Iron	Lb/ Lb Part 1 Resin	Lb/Ton Iron	Lb/ Lb Part 1 Resin	Lb/Ton Iron	Lb/ Lb Part 1 Resin
Benzene	x	x	8.41E-02		4.24E-03		6.06E-02		1.93E-02	
Toluene	x	x	3.40E-02		1.71E-03		2.15E-02		1.08E-02	
Ethylbenzene	x	x	3.37E-03		1.84E-04		1.87E-03		1.32E-03	
Xylene	x	x	2.08E-02		8.34E-04		1.15E-02		8.48E-03	
Styerene	x	x	2.75E-03		1.85E-04		1.54E-03		1.03E-03	
Cumene	x	x	4.52E-04		2.31E-05		2.65E-04		1.64E-04	
Phenol	x	x		9.69E-03		3.91E-04		1.04E-02		3.05E-03
1,2,4 Trimethylbenzene	x		7.47E-03		3.77E-04		3.90E-03		3.19E-03	
Cresol	x	x	3.91E-02		8.19E-04		1.13E-02		2.70E-02	
Naphthalene	x	x	2.38E-02		4.68E-04		9.38E-03		1.40E-02	
Biphenyl	x	x	6.01E-03				1.31E-03		4.70E-03	
Formaldehyde	x	x		1.86E-03		1.59E-05		1.14E-03		4.11E-04
Acetaldehyde	x	x	7.14E-03		2.32E-04		3.29E-03		3.62E-03	
Acrolein	x	x	4.83E-03		5.75E-04		2.43E-03		1.82E-03	
Acetone	x		4.17E-06				4.17E-06			
Butylaldehyde	x		1.48E-03		3.76E-05		6.26E-04		8.17E-04	
Benzaldehyde			3.35E-03		8.04E-05		2.30E-03		9.74E-04	

SARA means the Superfund Amendments and Reauthorization Act of 1986, Public Law 99-499, as amended (42 U.S.C. 9601 et seq.).

References

AFS and C. I. S. As
Foundries. D

Bates, C. E. and W.
Relationshi
Iron." AFS

Bernard, W. R. (19
pollutants.

Carey, P. R. (1986
(July 1986

Carey, P. R. (1986
M&T(Sept

Carey, P. R. (199
Managem

Euvrard, R. and B
Foundry..

Gschwandtner, G
and Toxic

Kiafka, S. and J.
annual M

Maysilles, J. (199
Project.

McKenley, M. D
Survey of

Mosher, G. (199
Founddry

Mosher, G. E. (19
Shakeout.

References

AFS and C. I. S. Association (1995). FORM R - Reporting of Binder Chemicals Used in Foundries. Des Plaines,IL, American Foundrymen's Association.

Bates, C. E. and W. D. Scott (1975). "The Decomposition of Resin Binders and the Relationship Between Gases Formed and the Casting Surface Quality Part 2-Gray Iron." AFS Transactions 134: 793-804.

Bernard, W. R. (1990). Emission factors for Iron and Steel Sources- Criteria and toxic pollutants. North Carolina, EPA, Research triangle Park, North Carolina.

Carey, P. R. (1986). "Updating Resin Binder Processes - Part VI." FOUNDRY M&T (July 1986): 84-88.

Carey, P. R. (1986). "Updating Resin Binder Processes - Part VII." FOUNDRY M&T(September 1986): 90-98.

Carey, P. R. (1990). "Today's Resin Binder Processes for Coremaking." FOUNDRY Management & Technology: 32-39.

Euvrard, R. and B. Jackson (1992). Case Study: Air Audit at a Medium Size Gray Iron Foundry., A.F.S.

Gschwandtner, G. and S. Fairchild (1990). Emission Factors for Iron Foundries - Criteria and Toxic Pollutants. Durham, NC, E.H. Pechan & Associates, Inc.

Klafka, S. and J. Loeffle (1995). Measurement of Organic Toxics at Iron Foundry. 88th annual Meeting & Exhibition, san Antonio, Texas.

Maysilles, J. (1993). Review of Foundry Emissions Data, US EPA Foundry MACT Project.

McKenley, M. D., L. A. Jefcoat, et al. (1990). "Air Emissions from Foundries: A Current Survey of Literature, Suppliers and Foudrymen." AFS Transactions: 979-990.

Mosher, G. (1995). AFS Title V Seminar, January 24 - 25, 1995, American Founddrymen's Society, Inc.

Mosher, G. E. (1994). "Calculating Emission Factors for Pouring, Cooling and Shakeout." Modern Casting: 28-31.

Renman, L., C. Sangö, et
Emissions from T
American Industri

Scott, W. D. and C. E. B.
Relationship Betv
Transactions 103

Scott, W. D. and C. E. B.
EMissions. Symp
Hartford, CT, US

Scott, W. D., C. E. Bates
Transactions 98:

Scott, W. D. and C. E. F
Birmingham, Ala

USEPA and N. Researc
Casting. North C

Wallace, D. and C. J. Co
Kansas City, Mic

Renman, L., C. Sangö, et al. (1986). "Determination of Isocyanate and Aromatic Amine Emissions from Thermally Degraded Polyurethanes in Foundries." Journal of American Industrial Hygiene Association. 47(October): 621 -628.

Scott, W. D. and C. E. Bates (1975). "Decomposition of Resin Binders and the Relationship Between Gases Formed and the Casting Surface Quality." AFS Transactions 103: 519-524.

Scott, W. D. and C. E. Bates, PhD (1976). Measurement of Iron Foundry Fugitive EMissions. Symposium on Fugitive Emissions Measurement and Control. Hartford, CT, US EPA.

Scott, W. D., C. E. Bates, et al. (1977). "Chemical Emissions from Foundry Molds." AFS Transactions 98: 203-208.

Scott, W. D. and C. E. Feazel (1976). A Review of Organic Sand Binder Chemistry. Birmingham, Alabama, Southern Research Institute.

U.S.EPA and N. Research Triangle Park (1980). Environmental Assessment of Iron Casting. North Carlina, Industrial Environmental Research Lab.

Wallace, D. and C. J. Cowherd (1979). Fugitive Emissions from Iron Foundries. Kansas City, Midwest Research Institute.

St

3.1 Problem St

Since 1970, most of t
Agency have been ba
being recommended.
emissions and then, r
of the major sources.
appropriate tool to ac
highly variability and
(Finley and Paustenb

The hypothesis of the
compounds for the ca
and build a strategy fo
evaluation tool.

Chapter 3

Strategy to Risk Assessment Modeling

3.1 Problem Statement

Since 1970, most of the regulations developed by the U.S. Environmental Protection Agency have been based on an end-of-pipe pollutant control strategy. A new strategy is being recommended, that is, to weigh far in advance the risks associated with potential emissions and then, reduce the high risk emissions at the source. This is a challenge to all of the major sources, in particular the foundry industry. Risk assessment may be the most appropriate tool to achieve this goal, but a major hindrance to applying this process is the highly variability and uncertainty in many factors used in making a risk assessment (Finley and Paustenbach 1994; Frey and Cullen 1995).

The hypothesis of the research discussed here is that one can establish a set of target compounds for the casting process that are amenable to pollution prevention techniques, and build a strategy for implementation of corrective action using risk assessment as an evaluation tool.

3.2 Modeling App

identification of significa

recognition of the locatio

spatial transport, and the

problem, a three part mo

model; (b) dispersion m

3.3 Source Mode

Several acceptable met

factors, engineering eq

emissions from the fur

manufacturing process

required accuracy.

The most effective alt

foundry. A mass bala

one accounts for mass

losses by chemical re

process separately an

several assumptions a

compositions and rat

3.2 Modeling Approach

Identification of significant risks, and their corresponding management require the recognition of the locations of environmental releases of toxic chemicals, the pathways of spatial transport, and the routes to human and ecological exposure. To approach this problem, a three part model (see Figure 3.1) with a feed back loop is proposed: (a) source model; (b) dispersion model; and (c) risk model.

3.3 Source Model

Several acceptable methods for computing emissions rates (stack testing, emission factors, engineering equations and material balances) can be used to quantify the emissions from the furnace, the pouring, shakeout, and other processes involved in the manufacturing process. The approach selected is dependent on cost, available data and required accuracy.

The most effective alternative is to apply a mass balance to every operation within the foundry. A mass balance is the process by which, in a well contained control volume, one accounts for mass rates of a chemical in and out of the system, including gains and losses by chemical reactions and other means. This method can be applied to each process separately and for each chemical used. Some areas of complexity will require several assumptions about HAP emissions from different process stages, binder chemical compositions and ratios, and capture and control efficiencies.

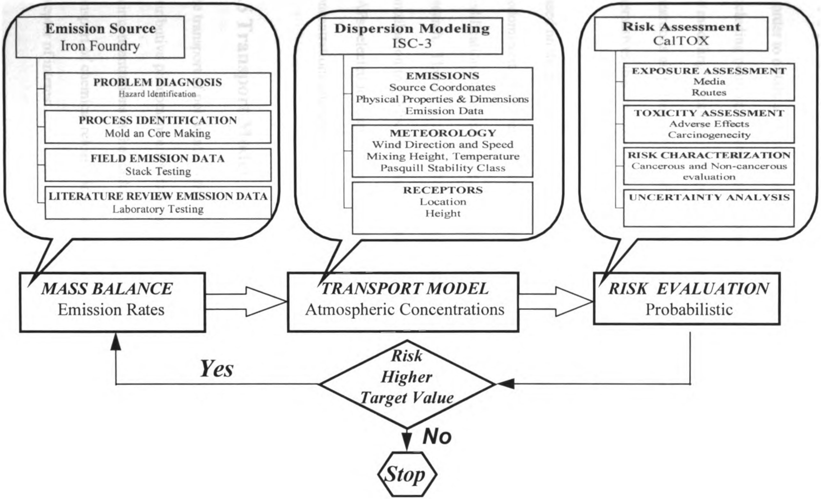


Figure 3.1. Risk Assessment Model for Pollution Prevention

3.4 Processes Sele

In order to obtain a tractab
including pouring, coolin
the modeling technique.
hazardous air pollutants (
alternatives that may be

Based on the percentag
predominant. Their em
modification of the ma
research. Therefore, th
contribution to HAPs.
HAPs selected for imp
concentrations and th

3.5 Transport

The transport of poll
distributive phenom
their concentrations
transport of chemica
receptor of interest.

3.4 Processes Selection and Research Scope

In order to obtain a tractable problem for modeling, the casting process in a foundry (including pouring, cooling, and shakeout) was selected as a case study for application of the modeling technique. This process was selected because it is a major source of hazardous air pollutants (HAPs) and because there are a number of pollution prevention alternatives that may be evaluated.

Based on the percentages presented in the previous chapter, the metal HAPs are predominant. Their emission reduction will not be achieved though, without modification of the manufacturing process. This was not the intent of the present research. Therefore, the volatile organic compounds were focused on, despite their contribution to HAPs. Benzene, formaldehyde, phenol, toluene and xylene were the HAPs selected for implementation in the transport model based on their high concentrations and their toxicity levels.

3.5 Transport Model

The transport of pollutants, both chemical and biological, over distances is a complex distributive phenomenon which reduces ambient concentrations of pollutants compared to their concentrations at the stacks. Therefore, it is essential to carefully model the transport of chemical releases in order to predict their fate and concentrations at the receptor of interest.

3.5.1 Selection of

Several transport model

Environmental Protectio

selected as the most app

3.5.2 Source Cha

The sources selected in

process lines in the fou

Meteorological data fo

obtained from the Mic

3.5.3 Selection o

An arbitrary grid was

kilometer square cente

exposure assessment.

3.6 Risk Model

During this final step.

effects of carcinogens

using a probabilistic a

3.5.1 Selection of a Dispersion Model

Several transport models were investigated for use in the case study. The U.S. Environmental Protection Agency's Industrial Source Complex model (ISC3) was selected as the most appropriate dispersion model.

3.5.2 Source Characterization

The sources selected in the case study are stacks collecting emissions from three casting process lines in the foundry. They were considered to be point sources.

Meteorological data for the region of Saginaw for five years from 1987 to 1991 were obtained from the Michigan Department of Environmental Quality.

3.5.3 Selection of Receptors

An arbitrary grid was built around the facility to screen the region on a two by two kilometer square centered at the plant. A smaller set of receptors is considered for exposure assessment.

3.6 Risk Model

During this final step, an exposure assessment, a toxicity assessment of the adverse effects of carcinogens and noncarcinogens, and characterization of the risk is conducted using a probabilistic approach.

3.7 Feed Back Loop

Using the risk approach, analysis of potential risk reductions at the source or from the use of alternate control systems are investigated.

References

Finley, B. and D. Paustenbach (1994). "The Benefits of Probabilistic Exposure Assessment: Three Case Studies Involving Contaminated Air, Water, and Soil." Risk Analysis 14(1): 53-73.

Frey, H. C. and A. C. Cullen (1995). Distribution Development for Probabilistic Exposure Assessment. 88th Annual meeting 7 Exhibition, San Antonio, Texas.

This chapter focuses

HAP emissions from

assess upper and low

binders used and the

examined to study th

sand concentrations

can be performed. S

assumptions are ma

critical to the accura

4.1 Methods fo

One of the biggest c

emissions inventory

factors, stack testing

Chapter 4

Source Model

This chapter focuses on the use of a chemical mass balance to determine the potential HAP emissions from the molding process. Different scenarios have been considered to assess upper and lower bounds on organic emissions based on records of the quantities of binders used and their compositions. A range of capture and control efficiencies has been examined to study their impact on the calculated potential emissions. By tracking the sand concentrations before and after casting, a reasonable evaluation of the emitted HAP can be performed. Since no measurements of the sand concentrations are available, some assumptions are made in order to obtain these concentrations. These assumptions are critical to the accuracy of the results.

4.1 Methods for Developing a Source Model

One of the biggest challenges in developing the source model is to compile a reliable emissions inventory. Emissions can be estimated through material balances, emission factors, stack testing, or engineering equations(Li, Karell et al. 1995).

4.1.1 Material Ba

A mass balance around

amount of the compour

equipment to the amou

within it or converted t

further consideration o

necessary. Despite the

other methods, it shoul

a very small error in a

material balance.

4.1.2 Emission F

Emission factors for sp

basis, are listed in the

derived from old units

tend to give the worst-

these values can be use

4.1.3 Stack Test

Stack testing is the mo

per billion level are pos

4.1.1 Material Balance

A mass balance around a piece of equipment in a process can provide an estimate of the amount of the compound exiting in the system by adding the quantity entering the equipment to the amount formed by chemical reactions minus the amount accumulated within it or converted to another compound. In case it is not recovered as a product, further consideration of alternate loss pathways such as solid, water, and air emissions is necessary. Despite the fact that material balance is relatively inexpensive compared to other methods, it should be used with care and be verified by other means. For instance, a very small error in a concentration measurement can result in a large error in the material balance.

4.1.2 Emission Factors

Emission factors for specific operations, on a pound of pollutant per operational unit basis, are listed in the EPA's reference manual, AP-42 (U.S.EPA 1991). These are derived from old units and may not be representative of the ones in use today. They also tend to give the worst-case estimated emissions (Li, Karell et al. 1995). Nevertheless, these values can be used to compare results generated by other means.

4.1.3 Stack Tests

Stack testing is the most accurate way to measure emissions. Measurements at the part per billion level are possible and can give very accurate information. However, as with any other analytical m

sampling and analysis

to verify the results of

4.1.4 Engineeri

Engineering estimate

engineering equation

conditions may be us

cost and accuracy si

losses (Li. Karell et

4.2 Factors Af

Several factors can

materials at the han

environmental cont

emissions.

4.2.1 Capture

One hundred perce

raw material transp

control system's bu

any other analytical method, results are not exempt from errors. In addition, the cost of sampling and analysis limits the use of stack testing to selected high priority emissions or to verify the results of other methods of calculation.

4.1.4 Engineering Equations

Engineering estimates are based on a theoretical analysis of an actual situation. Several engineering equations that provide estimates of the volatility of a chemical under diverse conditions may be used to estimate emissions. This method represents a balance between cost and accuracy since no testing is needed and safety factors may be used to account for losses (Li, Karell et al. 1995).

4.2 Factors Affecting Emission Rate Estimates

Several factors can alter emission rate calculations. Factors such as losses of input materials at the handling and the preparation step, the capture efficiency of hoods, and the environmental control system efficiency can significantly reduce or enlarge the rate of emissions.

4.2.1 Capture Efficiency

One hundred percent capture of the different emissions during mold and core making, raw material transport, and most importantly at the pouring step is a challenge to the control system's builders. Due to the layout of the casting process, a major part of the emissions escapes t

should also accoun

area of the mold, th

mold, etc., should b

1995). In this stud

the ventilation syst

(ACGIH, 1974; M

4.2.2 Control

There are several s

and volatile organi

scrubbers and con

to be operational u

interference (Aller

production operati

mixing with binde

for extraction of p

their efficiencies i

contemporary inci

9[illegible]% to 99%, depe

reduce the use of f

requirements (Coo

emissions escapes the control system and is considered to be a fugitive emission. One should also account for these losses to the atmosphere. Many factors such as the surface area of the mold, the exhaust air flow, the temperature, the height of the hood from the mold, etc., should be considered in determining the ventilation rate(AFS 1972; Belglund 1995). In this study, only two factors were considered in evaluating capture efficiency: the ventilation system characteristics and the surface area covered by the process (ACGIH. 1974; McDermott 1985).

4.2.2 Control Efficiency

There are several state-of-the-art technologies for the control of hazardous air pollutants and volatile organic compounds. These include thermal and catalytic incineration, scrubbers and condensers, and carbon adsorption. These technologies have been proved to be operational under conditions of low concentrations and low particulate matter interference (Allen, Archibald et al. 1991). The major pollutant emitted in mold and core production operations is particulate matter from sand reclaiming, sand preparation, sand mixing with binders and additives. Thus, carbon adsorption is not a feasible alternative for extraction of pollutants. Rate calculations for these control systems should account for their efficiencies in oxidizing or scrubbing the targeted toxics. For instance, contemporary incinerators are designed to achieve VOC destruction efficiencies from 90% to 99%, depending on their applications. But, they are often run at 95% efficiency to reduce the use of fuel (Allen, Archibald et al. 1991), and to minimize energy consumption requirements (Cooper and Green 1978). As discussed previously, at the Saginaw

Malleable Iron Plan

directed to a wet sc

interest are readily

4.3 Mass Bala

Currently, stack tes
inventories. This m
The tests may indic
will not give any in
are vented to one st
the foundry are the
testing data do not p
Thus, it is not possi

The most effective a
complexity are listed

- multiple
  binding m
  reclamati
- various bi
  to chemic
- organic co
  break dow
- efficiency

Malleable Iron Plant, the emissions from the pouring step are captured by a hood and directed to a wet scrubber. No data on the wet scrubber efficiency for the VOCs of interest are readily available.

4.3 Mass Balance as a Modeling Tool

Currently, stack tests are used by the foundry industry to perform air emission inventories. This method provides accurate emission data at the time of measurement. The tests may indicate which HAP or HAPs the foundry is not in compliance but they will not give any indication from where these chemicals come. When multiple exhausts are vented to one stack, the stack test data will not reveal which specific operations within the foundry are the major sources of hazardous air pollutants. Furthermore, the stack testing data do not provide a functional relationship between the source and the emission. Thus, it is not possible to model the effect of process changes on emissions.

The most effective alternative is to apply a mass balance approach. Some areas of complexity are listed below:

- multiple stages of HAP emissions that begin with the initial exposure of the binding material to the atmosphere during mixing and continue through sand reclamation;
- various binding material compositions in the sand with the multiple stages due to chemical reaction and evaporation;
- organic compounds in question are difficult to characterize because they may break down or react to form other related organic compounds; and
- efficiency of the capture and control equipment is highly variable.

In the following discus
presented to determine
the variables of conce
modeling the input fu
of identifying the pot
methods.

4.3.1 Mass Bal

Effective performan

- Mold an
- Producti
- Product
  operates
- Informa
- Binder
  making
- Trade n
  concen
- Binder
- Percent
  each or
  for eac
- Captur
- Contro
- Air flo
  the stac

In the following discussion, a simplified application of the mass balance approach is presented to determine concentrations at the stack. The exercise is used to demonstrate the variables of concern and to show the form of the relationships that may be used in modeling the input function of the risk assessment. This exercise also begins the process of identifying the potential areas to explore for application of pollution prevention methods.

4.3.1 Mass Balance Variables

Effective performance of a sand system mass balance requires the following:

- Mold and core sand use per hour;
- Production rates which include tons of metal charged per hour;
- Production schedule which includes hours a day and days a year the plant operates;
- Information regarding multiple line use within the plant;
- Binder system (cold-box, Hot-Box, green sand, etc...) used in mold and core making;
- Trade names and initial chemical composition of the binders (to obtain the concentrations of the organic compounds of interest);
- Binder use per hour;
- Percent evaporation, percent reaction, and percent remaining in core for each organic contained in the binders. (This will require air/sand analysis data for each stage of the operation);
- Capture technology employed and its efficiency for each stage;
- Control technology employed and its efficiency for each capture device; and
- Air flow rates associated with the capture, control, and ultimate exit through the stack.

... fundamental assumptio

... a probability distrib

...

- Variation in binder c
- Variation in emissio
- Variation in product

4.2 Chemical Input

... an estimation c

... using the b

... that the mass r

... are equal and that e

4.3 Chemical Ou

... pathways were cons

... system and chen

... introducing a cap

... first approximati

... limit concentra

... wasted sand was

Because a fundamental assumption in developing the model is that each modeled parameter has a probability distribution, the input model must also account for the following:

- Variation in binder composition;
- Variation in emission rate; and
- Variation in production rate.

4.3.2 Chemical Input Calculation

For this work, an estimation of the initial concentration of the chemical in the molded sand is obtained using the binder use rates given at the Saginaw Malleable Iron foundry. It is assumed that the mass rates of sand use in and out of the control volume (Q_{in} and Q_{sand}) are equal and that everything is well contained in the control volume.

4.3.3 Chemical Output Calculation

Two pathways were considered in the output calculations: chemicals intercepted by the exhaust system and chemicals remaining in the wasted sand. Fugitives were accounted for by introducing a capture efficiency coefficient strictly related to the exhaust system.

As a first approximation to determine the concentration in the wasted sand, C_{sand}, an upper limit concentration equal to the universal treatment standard for land disposal of the wasted sand was assumed (Federal Register 1994).

With careful considera

the sand before and af

for the components in

can be obtained (AFS

to account for the los

control system used.

in. β and the exhaus

4.3.4 Mass Ba

The material mass

Figure 4.1 is obtain

Acc

$$\frac{M\,dC}{dt} = C_{in} \times$$

Where

M =

dC/dt =

C_{in} =

Q_{in} =

C_{out} =

Q_{out} =

C_{sand} =

Q_{sand} =

With careful consideration of measured values (when available) of the concentrations in the sand before and after molding, and knowing the percentages of the reacted amounts for the components in the resin binders, a reasonable evaluation of the chemical emission can be obtained (AFS and Association 1995). Two coefficients μ and ß were introduced to account for the losses due to the capture efficiency of the hood and the efficiency of the control system used. The sensitivity of the concentration at the stack, C_{stack}, to variations in , ß and the exhaust rate, Q_{ex}, are of interest.

4.3.4 Mass Balance Equation for Casting

The material mass balance equation for a chemical *i* based on the scheme illustrated in Figure 4.1 is obtained :

Accumulation = Mass In - Mass Out ± Reactions

$$\frac{M\,dC}{dt} = C_{in} \times Q_{in} - C_{out} \times Q_{out} - C_{sand} \times Q_{sand} \qquad (4.1)$$

Where

M	=	mass of sand in control volume, g
dC/dt	=	concentration change rate of chemical, mg/g sand / unit time
C_{in}	=	initial concentration of chemical in mold, mg/g of sand
Q_{in}	=	mass rate of sand used for molding, g of sand /unit time
C_{out}	=	concentration of chemical out of the mold, mg/m^3 air emitted
Q_{out}	=	rate of gas flow out of the mold, m^3/unit time
C_{sand}	=	concentration of chemical remaining in the sand after pouring, mg/g of sand
Q_{sand}	=	mass rate of wasted sand, g/ unit time

POURING PROCESS

All values are on a per-hour basis

Sand: Sin = Sout = 3665 lbs

Nap = Naphthalene

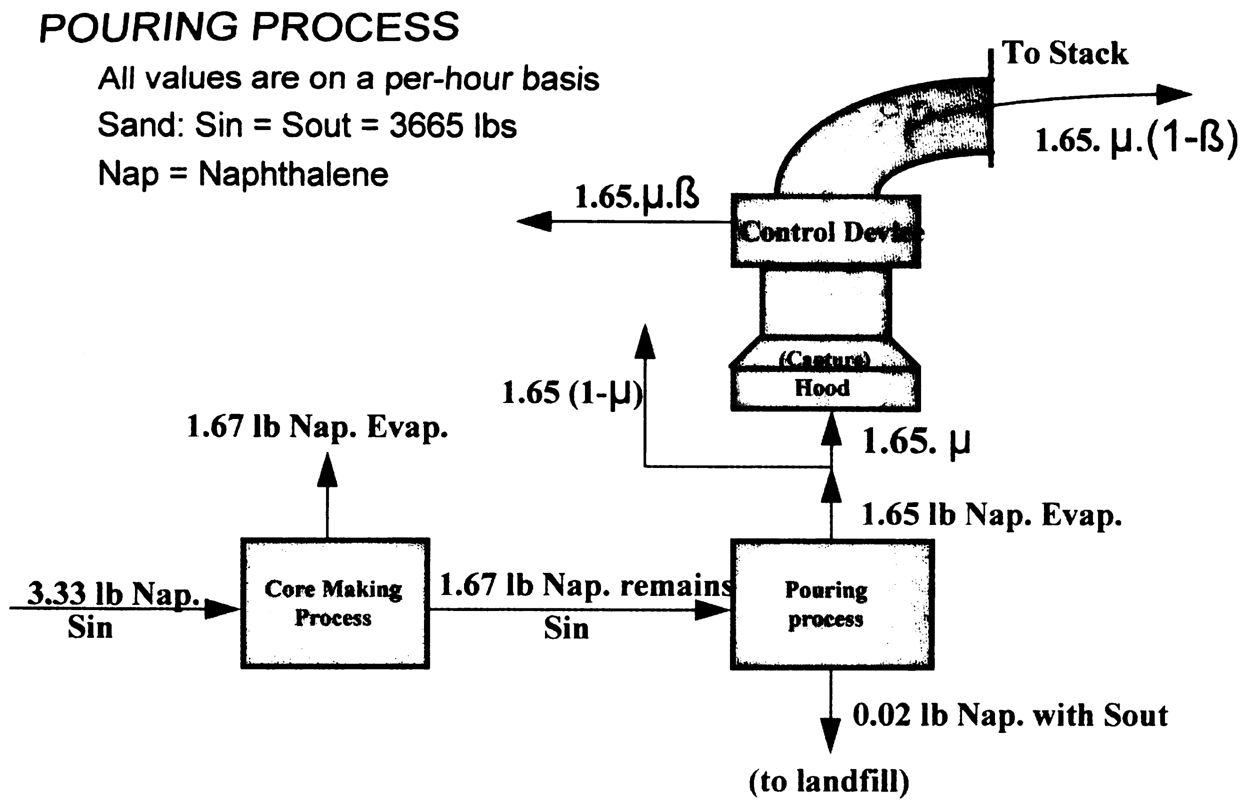


Figure 4.1 Desegregation of the Casting Process - Emissions Mass Balance

Since the goal is to de

control, C_{out} and Q_{out}

C_{stack}, and the exhaus

$$\frac{M\,dC}{dt} = C_{in} \cdot Q_{in} \cdot \Big($$

where

C_{stack} =

Q_{ex} =

μ =

β =

At steady state, it is

is occurring, the cha

is reduced to:

$$0 = C_{in} \cdot Q_{in} \cdot \Big(\frac{}{\mu \cdot (}$$

Solving for the conc

$$C_{stack} = \frac{C_{in}\ (}{(1.}$$

4.4 Mass Bala

Naphthalene was sel

balance approach. I

Since the goal is to determine the concentrations out of the stack after capture and control, C_{out} and Q_{out} are converted, respectively, to the concentration out of the stack, C_{stack}, and the exhaust flow rate, Q_{ex}. Equation (4.1) is then:

$$\frac{M\,dC}{dt} = C_{in} \times Q_{in} - \left(\frac{1}{\mu \cdot (1-\beta)}\right) C_{stack} \times Q_{ex} - C_{sand} \times Q_{sand} \qquad (4.2)$$

where

C_{stack}	=	concentration out of the stack of chemical, mg/m^3 of air exhaust
Q_{ex}	=	flow rate of exhaust air out of the stack, m^3/unit time
µ	=	capture efficiency coefficient in %
ß	=	control system efficiency coefficient in %

At steady state, it is assumed that no accumulation in the control volume of the chemical *i* is occurring, the change in concentration with respect to time is then zero. Equation (4.2) is reduced to:

$$0 = C_{in} \times Q_{in} - \left(\frac{1}{\mu \cdot (1-\beta)}\right) C_{stack} \times Q_{ex} - C_{sand} \times Q_{sand} \qquad (4.3)$$

Solving for the concentration of chemical *i* out of the stack, C_{stack} is then:

$$C_{stack} = \frac{C_{in}\ Q_{in} - C_{sand}\ Q_{sand}}{(1/\ \mu \cdot (1-\beta))\ Q_{ex}} \qquad (4.4)$$

4.4 Mass Balance Results and Discussions

Naphthalene was selected for the initial trial calculations as a quick test of the mass balance approach. It has chosen as an example of a process where major pollutants do not react but partiall

assumed to be emitt

Form R provided by

at the preparation st

50% evaporated du

pouring step. Since

a fraction of the ch

universal treatment

naphthalene is assu

The binder system

to the material saf

of 52% part I and

ratio of binder to s

initial concentratio

upcoming conside

estimated to be 64

4.1).

A sand-use-rate fo

selected to study th

environmental con

not react but partially evaporate at the sand preparation step. The remaining part is assumed to be emitted at the pouring step due to the contact with the hot melted metal. Form R provided by the American Foundrymen Society shows no reaction of naphthalene at the preparation step (AFS and Association 1995). It also suggests that this chemical is 50% evaporated during sand preparation. The other 50% is then in the mold at the pouring step. Since the sand can be disposed outside of Subtitle C, it is also assumed that a fraction of the chemical is found in the wasted sand at concentrations below the universal treatment standards for land disposal (for calculations, the upper limit for naphthalene is assumed to be 5.6 mg/kg).

The binder system selected for study is a phenolic urethane known as Isocure. According to the material safety data sheet, it is the combination of a two part resin. A typical ratio of 52% part I and 48% part II by weight of the phenolic urethane was adopted. A typical ratio of binder to sand between 1% and 2% by weight was assumed to determine the initial concentrations of naphthalene in molded sand. Based on the data provided and the upcoming considerations, the initial concentration of naphthalene in the sand was estimated to be 641.3 mg/kg of sand in the core before pouring (see detailed data in Table 4.1).

A sand-use-rate for production of cores at the Saginaw Malleable Iron foundry was selected to study the effect of selected capture efficiencies, exhaust flow rates and environmental controls on the concentrations of naphthalene released to the atmosphere.

The naphthalene co

flow rates are prese

control efficiencies

control has been al

illustrated in Figure

one order of magni

from 25,000 to 500

are presented in Ap

Table 4.

Concentration of nap
Use level or percent
Evaporation fraction
Reaction rate
Metal poured in tons
Core sand added in lb
Resin added in lb. hr
Universal treatment s

The naphthalene concentrations as a function of capture efficiency for different exhaust flow rates are presented in Figure 4.2 and Figure 4.3, respectively for 95% and 0% control efficiencies. The concentration of this chemical before and after environmental control has been also examined to account for the total emissions. The results are illustrated in Figures 4.4 and 4.5. The mass balance calculations showed a reduction of one order of magnitude of the concentration as a result of an increase of the exhaust rate from 25,000 to 500,000 ft^3/hour (see sample results in Table 4.2). Detailed calculations are presented in Appendix A.

Table 4.1 Assumptions Considered in the Mass Balance Calculations

Concentration of naphthalene in phenolic urethane	10.0%
Use level or percent ratio to sand	1.28%
Evaporation fraction before pouring	50.0%
Reaction rate	0.0%
Metal poured in tons/hr	112
Core sand added in lb./hr	7329
Resin added in lb./hr	94
Universal treatment standard for naphthalene in mg/kg sand [FR, 1994 #120]	5.6

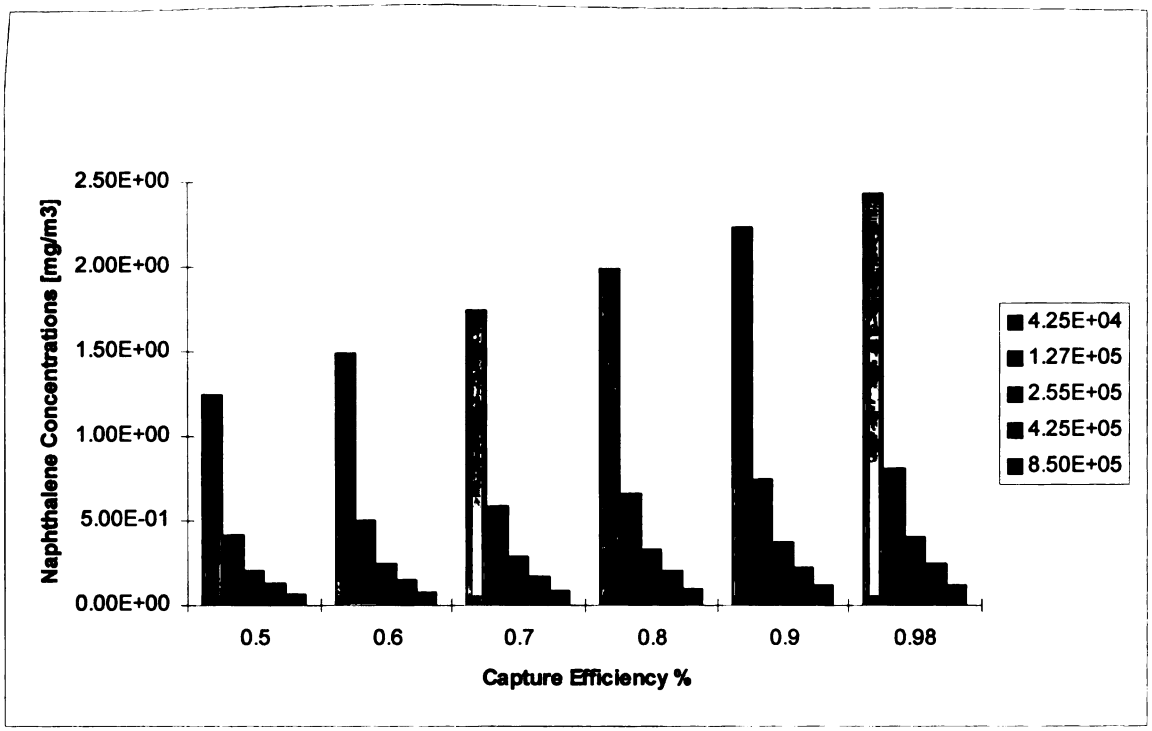


Figure 4.2 Naphthalene Stack Concentrations vs. Capture Efficiency for Variable Exhaust Rates [m^3/hr] with 95% Control

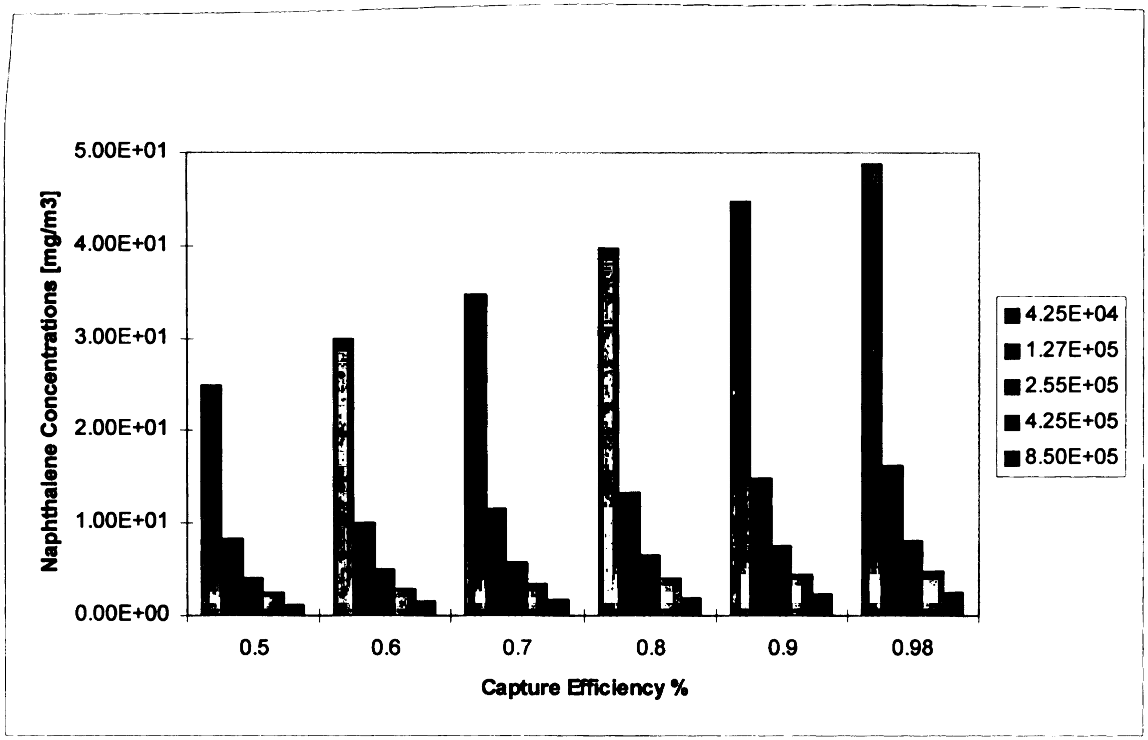


Figure 4.3 Naphthalene Stack Concentrations vs. Capture Efficiency for Variable Exhaust Rates [m^3/hr] with 0% Control

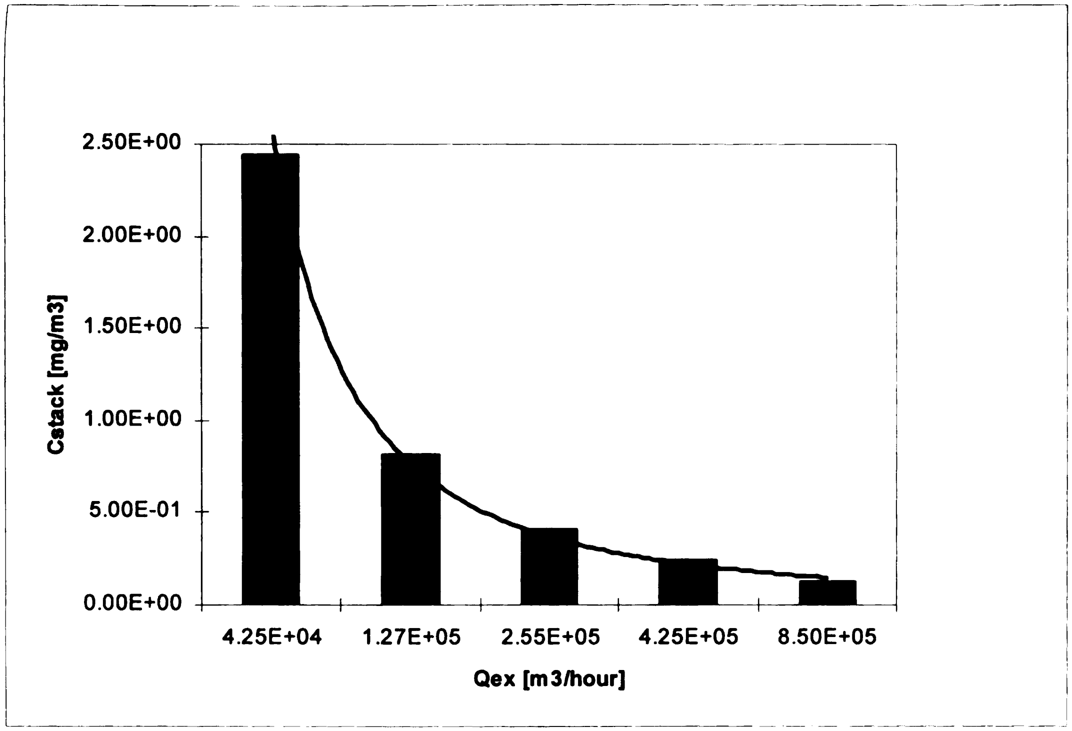


Figure 4.4 Naphthalene Stack Concentrations vs. Exhaust Flow Rates at 95% Control Efficiency

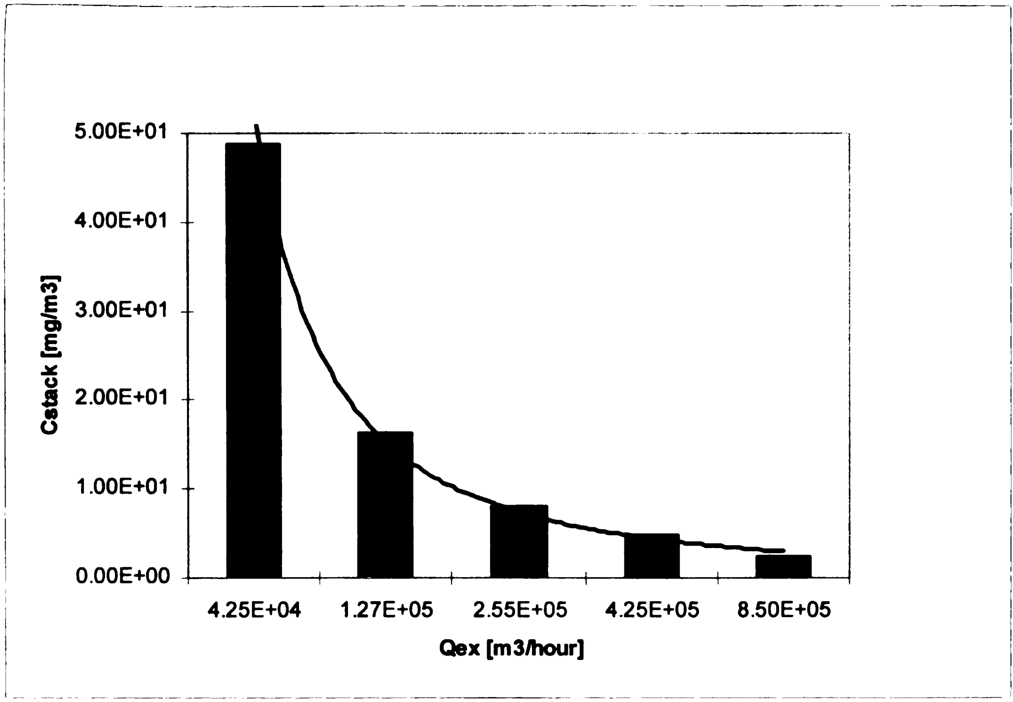


Figure 4.5 Naphthalene Stack Concentrations vs. Exhaust Flow Rates at 0% Control Efficiency

Table 4.2 Mass Balance Results for Naphthalene

Cin mg/g of sand	Qin g sand/hour	Cout mg/g of sand	Qsand g sand/hour	Qex m3/hour	µ % capture	ß % control	Cstack mg/m3
0.64128803	3.32E+06	0.0056	3.32E+06	**4.25E+04**	0.95	0.95	**2.36E+00**
0.64128803	3.32E+06	0.0056	3.32E+06	4.25E+04	0.95	0	**4.73E+01**
0.64128803	3.32E+06	0.0056	3.32E+06	**8.50E+05**	0.95	0.95	**1.18E-01**
0.64128803	3.32E+06	0.0056	3.32E+06	8.50E+05	0.95	0	**2.36E+00**

4.5 Compariso

Mosher provided ar

operations for eleve

derived in pounds o

These were obtaine

(average measurec

(((sand to met

From equation (4.5

This equation gives

control. For naphth

$22x10^{-6}$ lb. lb. of bi

The mass balance c

the same percentage

mg m^{3}. This conce

approximately 708

comparison purpose

example. An emiss

(concentration of t

4.5 Comparison of Mass Balance and Emission Factors

Mosher provided an easy way to calculate emissions of selected HAPs from molding operations for eleven different binder systems (Mosher 1994). Emission factors were derived in pounds of chemical released to air per pound of index or resin binder used. These were obtained based on the following formula:

$$\frac{\text{(average measured air concentration for a chemical)} * \text{(air volume sample)}}{\text{(((sand to metal ratio)} * \text{(metal in mold)} * \text{(resin in mold))} * 0.95)} \qquad (4.5)$$

From equation (4.5), one may note that a 95% capture efficiency was used by Mosher. This equation gives the total emission of the chemical before capture and environmental control. For naphthalene, with the same binder, Mosher obtained an emission factor of 22×10^{-6} lb./lb. of binder used (Mosher 1994).

The mass balance calculation, under the same conditions of 0% control efficiency using the same percentage of capture (95%), generated a concentration out of the stack of 47.3 mg/m^3. This concentration is calculated for an exhaust system rate (42,500 m^3/hour) approximately 708 times bigger than the sampling rate used by Mosher (60 m^3/hour). For comparison purposes, this concentration was converted to fit the conditions of the study example. An emission factor can be then determined using the following formula:

$$\frac{\text{(concentration of the chemical out of the stack)} * \text{(exhaust flow rate per hour)}}{\text{(resin use rate in mold per hour)} * (708)} \qquad (4.6)$$

A naphthalene em

differs from Mosh

of assumptions in

Mosher used one

(SRI) to develop I

the mass balance.

based on regulato

At this preliminar

the relationships I

as the input modu

alternatives may b

Of concern, howe

the composition o

phenolic urethane

component. Two

solvent in the forn

reported on the ma

explanation is that

required to resolve

A naphthalene emission factor of 66×10^{-6} lb./lb. of resin was obtained. This estimate differs from Mosher's by a factor of three. It is not unreasonable considering the number of assumptions involved in both Mosher's estimate and the mass balance. For example, Mosher used one half of the concentration reported by the Southern Research Institute (SRI) to develop his emission factor because SRI reported data at the detection limit. In the mass balance, however, the selection of the concentration remaining in the sand was based on regulatory standards rather than actual field data.

At this preliminary stage, it appears that the mass balance approach is sufficient to show the relationships between the variables of concern and that with calibration it can be used as the input module for the risk assessment. It also has value in that pollution prevention alternatives may be examined as a function of changes in resin composition.

Of concern, however, is the production of compounds not explicitly identified as part of the composition of input chemical. For example, benzene appears as an emission from phenolic urethane resin but is not listed on the Material Safety Data Sheet as a component. Two explanations are possible. One is that benzene was an impurity or solvent in the formulations tested by SRI that no longer exists and, therefore, is not reported on the material safety data sheet, MSDS, used for these calculations. Another explanation is that benzene is a reaction product of the casting process. More research is required to resolve this question.

References

ACGIH. (1974).
Arbor. M

AFS (1972). "E
1-17.

AFS and C. I. S
Foundr

Allen, G. R., J
Metal (
Americ

Belglund, R. (
Exhau

Cooper, H. B
Pollut
28(5):

FederalRegis
48001

Li, R., M. Ka
Chem

McDermott,
Butte

Mosher, G. F
Shak

U.S.EPA (19
NC,

References

ACGIH. (1974). Industrial Ventillation - A Manual of Recommended Practice. Ann Arbor, MI., Edwards Brothers Incorporated.

AFS (1972). "Exhaust Systems and Hood Design." Foundry Environmental Control 1(4): 1-17.

AFS and C. I. S. Association (1995). FORM R - Reporting of Binder Chemicals Used in Foundries. Des Plaines,IL, American Foundrymen's Association.

Allen, G. R., J. J. Archibald, et al. (1991). Hazardous Air Pollutants a Challenge to the Metal Casting Industry. 95th AFS Casting Congress, Birmingham, Alabama, American Foundrymen's Society Inc.

Belglund, R. (1995). "Effective Ventilation During Plating - Capture Efficiency for Rim Exhausts." MetaL Finishing 93: 79-83.

Cooper, H. B. and W. J. Green (1978). "Energy Consumption Requirements for Air Pollution Control Equipment at an Iron Foundry." Control Technology News 28(5): 545-548.

FederalRegister (1994). "Rules and Regulations." Federal Register 59(180): 47987-48003.

Li, R., M. Karell, et al. (1995). "Develop A Plantwide Air Emissions Inventory." Chemical Engineering Progress: 96-103.

McDermott, H. J. (1985). Handbook of Ventillation for Contaminent control. Boston, Butterworth.

Mosher, G. E. (1994). "Calculating Emission Factors for Pouring, Cooling and Shakeout." Modern Casting: 28-31.

U.S.EPA (1991). Compilation of Air Pollutant Emission Factors. Research Triangle Park, NC, U.S. EPA.

5.1 Introducti

Mathematical mode
in the atmosphere fo
Seigneur in 1993 (V
emitted into the air
and removal mechan
atmosphere. The bu
rise and buoyancy-in
to similar effects. L
plume towards the g

Venkatram and Seig
is based on two leve
while a more refined
pathways of interest
mathematical model.

Chapter 5

Transport Model

5.1 Introduction to Dispersion Modeling

Mathematical models for the transport, dispersion, transformation and fate of substances in the atmosphere for use in health risk assessment were reviewed by Venkatram and Seigneur in 1993 (Venkatram and Seigneur 1993). The transport and fate of substances emitted into the air depend on source characteristics, meteorology, atmospheric chemistry and removal mechanisms. Source characteristics determine the initial dispersion in the atmosphere. The buoyancy associated with high-temperature emissions leads to plume rise and buoyancy-induced spreading. Momentum associated with exit gas velocity leads to similar effects. Large buildings near the source create wakes that drive the emitted plume towards the ground at locations near the source.

Venkatram and Seigneur recommended an overall approach to health risk assessment that is based on two levels of analysis. The level 1 analysis provides a screening assessment, while a more refined assessment can be conducted for the substances and exposure pathways of interest using a level 2 analysis. A level 1 model was defined to be a mathematical model, that is applicable to any site, uses available data, and is acceptable

to regulatory agencies for specific applications. A level 2 model was defined to be a mathematical model, that may take into account specific features of the local environment and, therefore, may not be applicable to all sites, may require the collection of additional site-specific and/or chemical specific data, and is acceptable to the scientific community but is not necessarily a model recommended by regulatory agencies (Venkatram and Seigneur 1993).

5.2 Selection of the Dispersion Model

Because of the complex nature of the release and movement of hazardous air pollutants, a wide variety of available models have been proposed. The choice of the appropriate model for a specific situation depends on many factors, including user familiarity with the model, availability of model input data, desired precision of the estimate, and acceptability of the model by regulatory agencies and the scientific community.

Venkatram and Seigneur recommend the use of the EPA's Industrial Source Complex Version 2 (ISC2) for level 1 analysis. This model has two versions. The short-term version, ISCST2, can estimate concentrations averaged over one hour. The long-term version, ISCLT2, estimates annual averages using a statistical summary of meteorological data. This allows for short computation periods on modern microcomputers. The long-term version is more appropriate than the short-term for chronic risk assessment. The long-term version uses annual frequencies of meteorological variables whereas the short-term version uses sequential hourly meteorological data. Differences in concentrations (up to 30 percent) r

resolution of the m

km although many

both urban and ru

A literature surve

of "regulatory" G

the results of fiel

the "Cold Weath

Model Developm

showed that the

purposes. The c

comparisons of

showed an agree

Based on this li

model (ISC3) w

can be used to a

with an industri

The impact of b

level concentrat

(up to 30 percent) may occur between the two versions because of the difference in resolution of the meteorological data. The ISC model is applicable to distances up to 20 km although many studies extend this to 50 km from the source. It includes options for both urban and rural environments, that differ by their dispersion (Gratt and Levin 1995).

A literature survey conducted by Gratt and Levin in 1995 of studies comparing the results of "regulatory" Gaussian plume models, such as ISC2 (the current version is ISC3), with the results of field tracer tests designed to evaluate those and other models (for instance the "Cold Weather Plume Study" by Vaughn in 1987 and the "Green River Air Quality Model Development: VALMET- A Valley Air Pollution Model" by Whiteman in 1985), showed that the Gaussian models have limitations, but are quite good for predictive purposes. The comparison was limited due to temporal and spatial variations. Recent comparisons of concentrations generated by current models with field measurements showed an agreement within a few percent (Gratt and Levin 1995).

Based on this literature review, the revised version of the EPA Industrial Source Complex model (ISC3) was selected for this work. It is a steady state Gaussian plume model that can be used to assess pollutant concentrations from a wide variety of sources associated with an industrial source complex.

The impact of both short (ISCST3) and long (ISCLT3) term modeling on the ground level concentrations used for evaluation of risks due to acute, and chronic exposure were considered. It w

particular study l

short term mode

such as: settling

point and volum

point sources: a

areas, flat and c

averaging time

5.3 Role of

Atmospheric t

air as they are

concentrations

as buildings a

cooling until i

sinking to rep

wind speed, a

proportional t

However, hig

direction and

(e.g., stability

close to the s

considered. It was decided that, the short term version was more appropriate in this particular study because of the lack of meteorological data and the highr precision of the short term model. This model in its short version considers site-specific characteristics such as: settling and dry deposition of particles; downwash due to nearby buildings; area, point and volume sources; plume rise as a function of the downwind distance; multiple point sources; and limited terrain adjustment. It is appropriate for both rural and urban areas, flat and complex terrain, transport distances smaller than 50 km, different averaging times from one-hour to a year, and for continuous toxic air releases.

5.3 Role of Atmospheric Turbulence in Air Pollution

Atmospheric turbulence is the mechanism that dilutes and mixes pollutants with ambient air as they are transported by the wind. It plays a major role in determining ground level concentrations. Turbulence is produced mechanically by air flowing over obstacles such as buildings and hills, and thermally (process of convection) by warmer air rising and cooling until it reaches the temperature of its surroundings and conversely, by cooler air sinking to replace warm air. There are three important factors influencing turbulence: wind speed, atmospheric stability and mixing height. Concentration is inversely proportional to wind speed, i.e., the higher the wind speed the lower the concentration. However, high wind speeds are often associated with persistence in the downwind direction and can result in high ground level concentrations. During unstable conditions (e.g., stability class A) the plume from a tall stack will be mixed to ground level relatively close to the source, resulting in high short term concentrations. These concentrations can be significantly in

mixing height. S

concentrations du

conjunction with

downward sooner

conditions. (e.g.,

horizontal disper

remain close to t

for pollutant disp

decreases.

5.4 Theoret

The ISC3 short t

plume equation

source at each re

receptor by the c

For a steady stat

a crosswind dist

and modified by

be significantly increased when the unstable conditions occur in conjunction with a low mixing height. Some plumes will have their greatest impact on ground level concentrations during near neutral conditions (e.g., stability class D) and often occur in conjunction with high wind speeds. The high wind speed causes the plume to bend downward sooner and not reach as great a height as under a low wind speed. For stable conditions, (e.g., stability class F) the plume's vertical spread is severely restricted and horizontal dispersion is also reduced. Pollutants released during very stable conditions remain close to the ground. Finally, mixing height determines the volume of air available for pollutant dispersal; as the mixing height increases, the ground level concentration decreases.

5.4 Theoretical Background

The ISC3 short term model for point source emissions uses the steady-state Gaussian plume equation for a continuous elevated source. The hourly concentrations for each source at each receptor are summed to obtain the total concentration produced at each receptor by the combined source emissions (U.S.EPA 1995).

For a steady state Gaussian plume, the hourly concentration at downwind distance, x, and a crosswind distance, y, (Figure 5.1) as suggested by Pasquill (1961) (F.Pasquill 1962), and modified by Gifford (1961) is given by Equation 5.1.

Fi

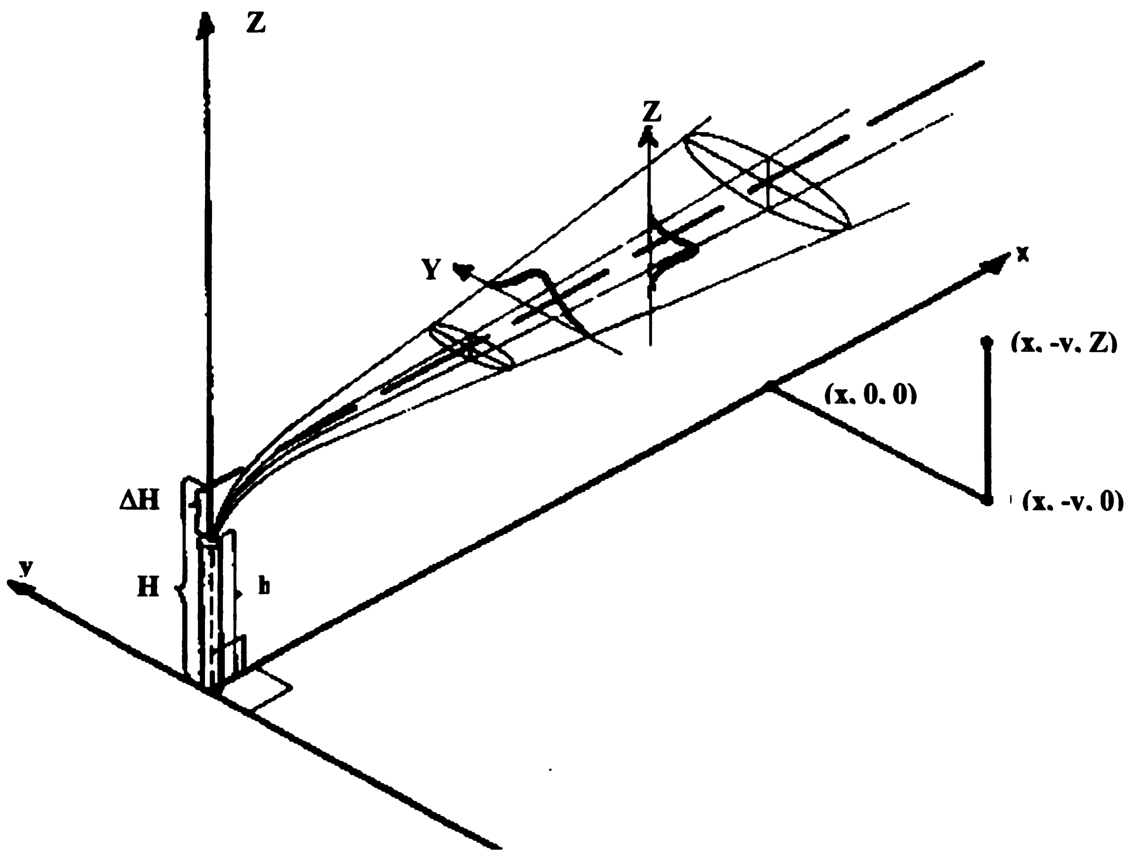


Figure 5.1. Coordinate System showing Gaussian Distributions
in the Horizontal and Vertical Directions

$\chi(x,y,z;H) = \frac{Q}{2\pi \ldots}$

Where

χ =

Q =
K =

V =
D =

σ_y, σ_z =
u_s =
H =

This equation is
that is no diffusi
continuous releas
between the sour
for this study. Th
long enough com

The effect of stab
structure of the at
over which the co
(Turner 1967).

$$\chi(x,y,z;H)=\frac{QKVD}{2\pi u_s\sigma_y\sigma_z}\exp\left[-0.5\left(\frac{y}{\sigma_y}\right)^2\right]\cdot\left\{\exp\left[-0.5\left(\frac{z-H}{\sigma_z}\right)^2\right]+\exp\left[-0.5\left(\frac{z+H}{\sigma_z}\right)^2\right]\right\} \quad (5.1)$$

Where

χ	=	concentration of gas or aerosols (particles less than 20 μm in diameter) at x, y, z from a continuous source with an effective height, H, $\mu g/m^3$
Q	=	pollutant emission rate, g/sec
K	=	a scaling coefficient to convert calculated concentrations to desired units (default value of 1×10^6 for Q in g/s and concentration in $\mu g/m^3$)
V	=	vertical term accounts for the vertical distribution of the Gaussian plume.
D	=	decay term, accounts for pollution removal by physical or chemical processes
σ_y, σ_z	=	standard deviation of lateral and vertical concentration distribution, m
u_s	=	mean wind speed, m/s, at release height
H	=	effective emission height, m

This equation is valid where diffusion in the direction of the plume travel is neglected, that is no diffusion occurs in the x direction (see Figure 5.1). This is the case of continuous release or when at least the duration of release is greater than the travel time between the source and the receptors of interest (Turner 1967). This is exactly the case for this study. The release is continuous for sixteen hours, and the duration of release is long enough compared to the travel time.

The effect of stability is considered in the values of σ_y, σ_z. These vary with the turbulent structure of the atmosphere, height above the surface, surface roughness, sampling time, over which the concentration is to be estimated, wind speed, and distance from the source (Turner 1967).

The effective stack

physical stack heig

stack. The differe

based on experim

true value (Turner

$$\Delta H = \frac{v_s \cdot d}{u_s}$$

Where

ΔH
v_s
u_s
d
p
T_s
T_a
2.68 x

At the ground lev

$\chi(x, y, 0; H) =$

At the centerline

$\chi(x, 0, 0; H) =$

The effective stack height, H, is used to account for the sum of the plume rise and the physical stack height, h. Rarely will this height correspond to the physical height of the stack. The difference between those heights, ΔH, as developed in Holland's equation, is based on experimental data. It provides a slight safety factor since it underestimates the true value (Turner 1967). Holland's equation is:

$$\Delta H = \frac{v_s \cdot d}{u_s} \cdot \left(1.5 + 2.68 \times 10^{-3} p \cdot \frac{T_s - T_a}{T_a} \cdot d \right) \tag{5.2}$$

Where

ΔH	=	rise of the plume above the stack, m
v_s	=	stack gas exit velocity, m sec^{-1}
u_s	=	wind speed, m sec^{-1}
d	=	inside stack diameter, m
p	=	atmospheric pressure, mb
T_s	=	stack gas temperature, °K
T_a	=	air temperature, °K
2.68×10^{-3}	=	constant, mb^{-1} m^{-1}

At the ground level (z = 0), the diffusion equation (5.1) is simplified to:

$$\chi(x,y,0;H) = \frac{QKVD}{2\pi u_s \sigma_y \sigma_z} \exp\left[-0.5\left(\frac{y}{\sigma_y}\right)^2\right] \cdot \exp\left[-0.5\left(\frac{H}{\sigma_z}\right)^2\right] \tag{5.3}$$

At the centerline of the plume (y = 0), a further simplification results:

$$\chi(x,0,0;H) = \frac{QKVD}{2\pi u_s \sigma_y \sigma_z} \exp\left[-0.5\left(\frac{H}{\sigma_z}\right)^2\right] \tag{5.4}$$

For a ground-l

ground level i

$\chi(x, 0, 0$

Equation (5.

the ground l

It is howeve

emissions b

building, bo

effects. Th

ISC3 code

these build

5.5 Dow

If the plum

stack, the e

called dow

by Paine in

the EPA w

For a ground-level source without effective plume rise (H = 0), the concentration at the ground level is finally:

$$\chi(x,0,0;0) = \frac{QKVD}{2\pi u_s \sigma_y \sigma_z} \tag{5.5}$$

Equation (5.3) is used in this study since the region of Saginaw is flat. Concentrations at the ground level will be considered.

It is however, necessary for this study to test the sources for possible downwash of the emissions by the nearby buildings. Since all the stacks are on the roof of the main building, both the main and the administration buildings will have potential downwash effects. This will be accounted for by the Building Profile Input Program (BPIP). The ISC3 code will then utilize BPIP to decide if the plume at any time will be influenced by these buildings.

5.5 Downwash effects and BPIP

If the plume is caught in the turbulent wake of the stack or a building in the vicinity of the stack, the effluent will be mixed rapidly downward toward the ground. This effect is called downwash. Different building downwash models were investigated and evaluated by Paine in 1996 (Paine 1996). The Building Profile Input Program (BPIP) provided by the EPA was selected for use in the calculation of the width and the height of influence every

implemented ex

The BPIP (Buil

projected build

Practice) Stack

to be manually

henceforth iden

Bulletin Board

GEP and is des

from structures

building height

which stacks ar

The second par

different BH ar

calculations on

formatted for e

is set by BPIP t

Equation 5.1 by

influence every 10 degrees for 360 degrees. This model has the advantage of being implemented exclusively for ISC3, which led to its selection.

The BPIP (Building Profile Input Program) is designed to calculate building heights and projected building widths based on an implementation of GEP (Good Engineering Practice) Stack Height and building downwash guidance. The output data from BPIP has to be manually edited into the appropriate ISC2 input runstream. This program is henceforth identified by its name and a Julian date; i.e., BPIP (dated 93320) in the EPA's Bulletin Board. The BPIP is divided into two parts. The first part is based solely on the GEP and is designed to determine whether or not a stack is being subject to wake effects from structures. Several values are determined such as the GEP stack height, GEP related building height (BH) and the projected building width (PBW). Flags are set to indicate which stacks are being affected by which structure wake.

The second part calculates building downwash BH's and PBW's which can lead to different BH and PBW values than those calculated for GEP. This part performs the calculations only if a stack is being influenced by structure wake effects. Output is formatted for editing either into the ISC3 input runstream (U.S.EPA 1995) or, if the flag is set by BPIP to indicate that downwash is to be considered, then ISC-3 modifies Equation 5.1 by adjusting σ_y.

5.5.1 Inpu

The structure
downwash gu
building whe
multitiered b
in this study,
administratio

Stacks can b
downwind f
designed to
This is contr
stack is on a

Input data to
BPIP will ca
stack.

The BPIP pr
buildings we
elevation. T
with the num
setting see Ap

ıput Preparation

ture-source relationships must be assessed with respect to the GEP and building h guidance. Two methods are available. The first way is as a multitiered ʌhere each tier is treated as a stand-alone structure. The alternative is as a ·d building with two towers that may be combined. The first method was used .dy, since only two buildings were considered: the main building, and the ation building next to it.

n be on top of roofs and also can be more than 5 times the building length, L, d from an upwind roof edge. The main algorithms in the BPIP were not to process these stacks if they are further than 5L downwind from a roof edge. ›ntrary to guidance. An algorithm was written to automatically detect when a n a roof. In our case all stacks are on top of the main building roof.

a to the BPIP uses normal building dimensions and orientation in all cases. The l calculate 36 pairs of BH and PBW values for input to the ISC3 model for each

' processes input data on a structure by structure basis. In the case study, two were identified by a name (maximum of 8 alphanumeric characters) and base . The number of tiers and tier heights for each structure was determined along ıumber of corners for each tier. For details on the file structure and program e Appendix B.

5.6 Dispe

The Industria

(U.S.EPA 19

the source.

modeling. t

5.6.1 So

The data w

manufactu

- I
-
-
-
-
-
-
-
-
-

Due to th

molding

produces

simultan

5.6 Dispersion Modeling Implementation - Simulation Strategy

The Industrial Source Complex (ISC3) dispersion model in the short term version (U.S.EPA 1995) was implemented for a two kilometer by two kilometer grid centered at the source. The following is a discussion of the data needed to perform the dispersion modeling, the sources of these data and assumptions used in implementing the model.

5.6.1 Source Information

The data were gathered on site at the facility. A tour of the entire plant and the different manufacturing processes was made to compile the following information:

- Map of the plant;
- Identification of stacks by source (e.g. mold, core, etc.);
- Number and location of stacks;
- Height of buildings and ground elevation;
- Stack internal diameters;
- Stack heights;
- Stack temperatures;
- Stack exit velocities;
- Mass emission rates (g/s) by stack; and
- Control equipment for each stack.

Due to the diverse types of pieces produced, three lines are in production to meet different molding needs and capacities. Line 1 produces: gears, yokes, and pistons; Line 2 produces: housings and line 3 produces: connecting rods. These lines can function simultaneously or individually depending on the furnaces' performance, the clients' demand, and, c

has a specific

binders.

All sources o

lines in the f

group of sta

designated t

of the castin

covered by

stacks for p

each step.

systems, a

height, inn

sources co

facility is i

5.6.2 Se

An arbitra

by two kil

establish t

elaborate

and, of course, the specifications of the metal produced. As expected, each line ecific mold and core make-up and very often requires different kinds of resin

ces of emissions are stacks collecting the fumes from the three casting process he foundry elected as the case study. They are assumed to be point sources. Each stacks is collecting emissions from one particular line. These stacks are also ed to collect separately emissions from the pouring, cooling, and shakeout steps sting process at each line. The line with the highest production rate (Line 1) is by six stacks (1 for pouring, 2 for cooling, and 3 for shakeout). Line 2 has two r pouring, one for cooling, and one for shakeout. And, Line 3 has one stack for . These stacks are equipped with different kinds of capture systems, control and exhaust systems. They also have different physical properties such as nner diameter, and elevation. Table 5.1 is a compilation of the data for the considered in this research. A mapping of their location with respect to the s illustrated in Figure 5.2.

Selection of Receptors

rary 50 m × 50 m grid was built around the facility to screen the region on a two ilometer square centered at the plant. This primary grid (Figure 5.3) was used to the pattern of concentration variability at the ground level and refine a more set of receptors for investigation in the exposure assessment.

5.6.3 Mete

Meteorologic
of Environme
used in the si
information

5.6.4 Em

Limited dat
the differen
and mass b
the few da
two orders
obtain acc
made beca
situation i
emission
to be usec
assumes t
Historical
In the cas
study (Sc
emissions

5.6.3 Meteorological Data

Meteorological files for the Saginaw region were acquired from the Michigan Department of Environmental Quality (DEQ). Data for the five years between 1987 and 1991 were used in the simulations. Only an electronic copy of these files was accessible. Detailed information is available in the ISC-3 output Appendix C.

5.6.4 Emission Rates -Variability

Limited data are available to characterize foundry emission rates due to the complexity of the different processes involved in the manufacturing process. Laboratory measurements and mass balance calculations with emission factors are among the methods used to develop the few data available. Data disagreement is, however, common and differences of one and two orders of magnitude are typical. Obviously, rigorous stack sampling is the only way to obtain accurate measurements of the real emissions but very few measurements have been made because of the cost. The selection of a set of data that best represents the real situation is a major challenge. Traditionally, a point value, most likely the maximum emission rate, has been used in determining the atmospheric concentrations at the receptor to be used in exposure assessment. The EPA base estimate line for exposure concentrations assumes the individual is exposed to the 95th percentile value over their lifetime. Historically, the only variability introduced in the risk evaluation is the meteorological data. In the casting process, toxic emissions are highly variable. Scott, James and Bates in their study (Scott, James et al. 1976) observed changes over time (30 to 40 min.) of these emissions corresponding to two peaks.

Table 5.1 Selected Stack Data

Stack ID	Designation	Process	X feet	Y feet	Elev. feet	Emission Rates	Exhaust CFM	Height feet	Temp. (F)	Diam feet
FFE5845	POURING1	#1 ML, Pouring RMIP	259106 4	4809784 5	62 00	0 6889964	66000	85 00	85 00	4 00
FFE5946	COOLING11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100 00	3 50

Table 5.1 Selected Stack Data

Stack ID	Designation	Process	X feet	Y feet	Elev. feet	Emission Rates	Exhaust CFM	Height feet	Temp. (F)	Diam feet
FFE5845	POURING1	#1 ML, Pouring RMIP	259106.4	4809784.5	62.00	0.6889964	66000	85.00	85.00	4.00
FFF5946	COOLING11	Cooling (#1ML Conv NOrth)	259090.8	4809779.7	62.00	4.9249760	17000	75.00	100.00	3.50
FFE6047	COOLING12	Sand Cooling (#1ML Ret 2)	259081.6	4809770.4	62.00	4.9249760	23000	75.00	100.00	3.50
FSC1953	SHAKEOUT11	Shakeout SRet	259063.4	4809745.1	13.00	1.0469950	32000	128.00	100.00	3.50
FSC2155	SHAKEOUT12	Shakeout2	259078.5	4809748.5	13.00	1.0469950	42000	128.00	100.00	4.00
FSC2256	SHAKEOUT13	Shakeout3	259084.9	4809742.0	13.00	1.0469950	42000	128.00	100.00	4.00
FEF5437	POURING2	#2ML, Pouring, RMIP	259175.4	4809796.3	13.00	0.1060000	48000	128.00	85.00	2.50
FEF5640	MAIN POUR2	Main Pouring #2 ML RMIP	259151.4	4809709.2	62.00	0.1060000	54000	128.00	85.00	4.00
FSC2783	COOLING2	#2ML, Cooling (#1ML SPO 1)	259143.5	4809701.2	55.00	3.0300000	40000	128.00	100.00	4.00
FEF2094	SHAKEOUT2	# 2ml Shakeout, Muller, Return Conveyor	259141.1	4809703.4	43.00	0.9650000	24000	75.00	212.00	3.00
FEF1774	MAIN POUR3	#3ML Pouring RMIP	259198.3	4809684.4	30.00	0.2120000	48000	219.4	85.00	4.00
FSC3199	SHAKEOUT3	#3ml Shakeout, Muller, Return Conveyor	259174.5	4809684.4	43.00	0.4825000	40000	219.4	100.00	4.00
FSC32100	COOLING3	#3ml Sand Belt, Cooler, Return Conveyor	259178.8	4809689.3	43.00	1.5150000	25000	219.4	100.00	4.00
ID	Designation	Type of Control	X m	Y m	Elev. m	Emission Rates	Exhaust CMS	Height m	Velocity m/s	Diam m
FFE5845	POURING1	None	78971.7	1465950.7	18.90	0.6889964	31.14	25.91	26.68	1.22
FFF5946	COOLING11	None	78967.0	1465949.3	18.90	4.9249760	8.02	22.86	8.98	1.07
FFE6047	COOLING12	None	78964.2	1465946.4	18.90	4.9249760	10.85	22.86	12.14	1.07
FSC1953	SHAKEOUT11	Schneible	78958.6	1465938.8	3.96	1.0469950	15.10	39.01	16.90	1.07
FSC2155	SHAKEOUT12	Schneible	78963.3	1465939.8	3.96	1.0469950	19.82	39.01	16.98	1.22
FSC2256	SHAKEOUT13	Schneible	78965.2	1465937.8	3.96	1.0469950	19.82	39.01	16.98	1.22
FEF5437	POURING2	None	78992.8	1465954.3	3.96	0.1060000	22.65	39.01	49.67	0.76
FEF5640	MAIN POUR2	None	78985.5	1465927.8	18.90	0.1060000	25.48	39.01	21.83	1.22
FSC2783	COOLING2	Schneible	78983.1	1465925.3	16.76	3.0300000	18.88	39.01	16.17	1.22
FEF2094	SHAKEOUT2	None	78982.3	1465926.0	13.11	0.9650000	11.33	22.86	17.25	0.91
FEF1774	MAIN POUR3	None	78999.8	1465920.2	9.14	0.2120000	22.65	66.87	19.40	1.22
FSC3199	SHAKEOUT3	Shneible	78992.5	1465920.2	13.11	0.4825000	18.88	66.87	16.17	1.22
FSC32100	COOLING3	Shneible	78993.8	1465921.7	13.11	1.5150000	11.80	66.87	10.11	1.22

Line 1

Area invesigated: 2km x 2km

Foundry

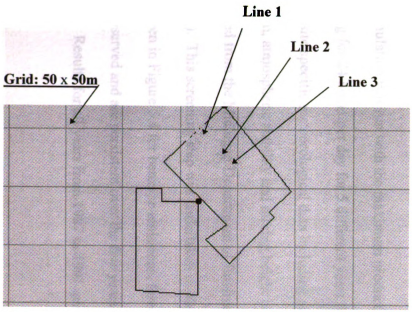


Figure 5.2 Stack Configuration.

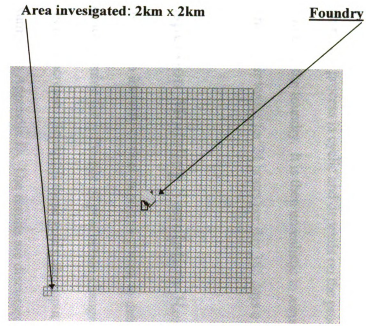


Figure 5.3 Receptor Location-Preliminary Grid

The first occu

Furthermore,

different lines

constant rate

5.7 Dispe

ISC3 was us

variation, to

to stack heig

in the examp

5.7.1 Ide

The first sin

were runnin

previously,

and directio

were acquir

Appendix C

As can be s

peaks are o

information

Appendix I

The first occurs at the pouring step and a less important peak is found at the mold break-up. Furthermore, the process is cyclic and depends on the production rate which varies for different lines in the foundry. It is then unrealistic to assume that the facility is emitting a constant rate of air toxics for 24 hours per day 365 days a year.

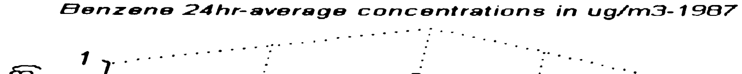
5.7 Dispersion Modeling Simulation-Results

ISC3 was used to identify critical exposure zones, to determine the sensitivity to emission variation, to examine the influence of production change, and to estimate the sensitivity to stack height increase. To fulfill these goals, the input file was implemented as shown in the example in Appendix D. The results are discussed in the following paragraphs.

5.7.1 Identification of Critical Zones

The first simulation was run with the maximum production rate assuming all three lines were running for 24 hours per day for 5 different years from 1987 to 1991. As mentioned previously, site specific meteorological data including ambient temperature, wind speed and direction, atmospheric stability and mixing height on an hourly basis for the region were acquired from the Michigan Department of Environmental Quality (see sample in Appendix C). This screening step was undertaken to identify critical zones of exposure. As can be seen in Figure 5.4 for benzene emissions, three critical regions with three peaks are observed and are persistent over the five years of the meteorological information. Results for all years from 1987 to 1991 are illustrated graphically in Appendix E.

Benzene 24hr-average concentrations in ug/m3-1987



Benzene 24hr-average concentrations in ug/m3-1988

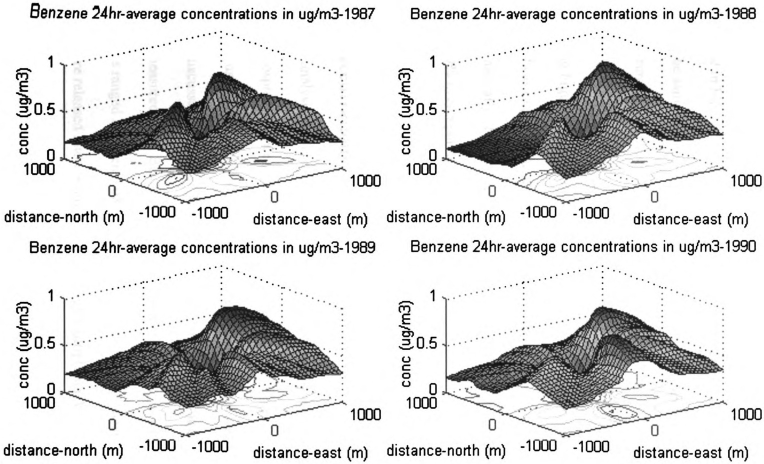


Figure 5.4 Average Benzene Concentrations in ($\mu g/m^3$) for four years of Meteorological Data with Maximum Emission Rates

5.7.2 Se

To better v

are illustra

observed.

sources wa

By compar

increases 1

expands dr

increases 1

5.7.3 Inf Co

A sensitivit

predicted at

process wer

pollutant as

level in the

emission rat

pollutants w

5.7.2 Sensitivity of Area of Exposure to Emission Increase

To better visualize the area impacted by a particular concentration, isoconcentration lines are illustrated in Figure 5.5, showing where the 3 zones mentioned previously are observed. The same scenario with an increase of 10% for the emission rates of all point sources was run for sensitivity analysis (see Figure 5.6).

By comparing Figure 5.5 and 5.6, one can see that not only the exposure concentration increases 10% as expected but also that the area of influence for a given concentration expands dramatically. For example, the area encompassed by the 0.6 $\mu g/m^3$ contour increases 100% in comparison to its original size.

5.7.3 Influence of Production Variation on Exposure Concentrations

A sensitivity analysis was conducted to study the effect of production rate on the predicted atmospheric concentration. Three lines implemented in the manufacturing process were used to produce different pieces of cast. Benzene was selected as the model pollutant as discussed in Chapter 3 Section 3.4 based on its toxicity and predominant level in the measured data. Benzene was also the model pollutant as a carcinogen. The emission rates ranged between 6.08E-02 and 6.21E-01 g/sec. The hazardous air pollutants were released into the atmosphere through multiple stacks.

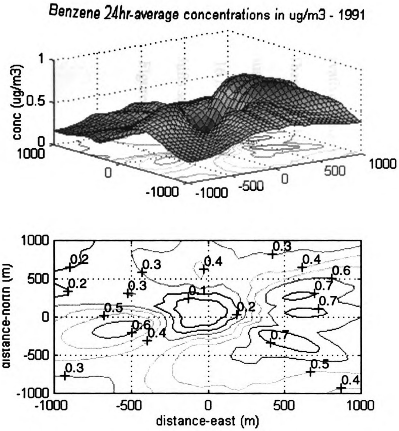


Figure 5.5 Average benzene isoconcentrations in ($\mu g/m^3$) for 1991 with maximum emission rates

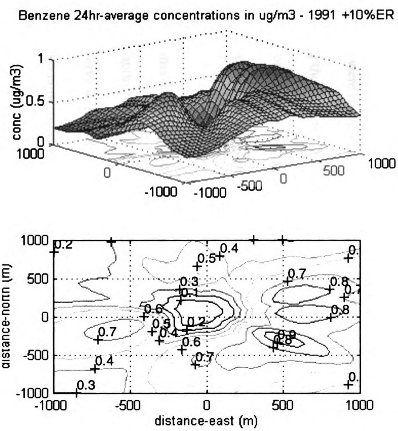


Figure 5.6 Average benzene isoconcentrations in ($\mu g/m^3$) for 1991 with 10% increased

To explore rea

simulations w

Considering t

the dispersion

selected recep

Different em

combining ap

one can obse

the maximum

necessarily d

differences i

receptor in c

Three conse

schedules. T

can only be

scenarios of

two 8 hour s

presented in

To explore realistic scenarios, the stacks were grouped in different combinations and simulations were run to study the effect on exposure concentrations at specific receptors. Considering the patterns observed in the first results, a transect was established to follow the dispersion of the pollutant moving southwest and northeast from the source. The selected receptors are illustrated in Figure 5.7. The plant is located at the mid point.

Different emission rates were investigated based on various scenarios obtained from combining appropriate sources grouped in the three production lines. From Figure 5.8, one can observe a shift of the highest concentration. From this figure, it can be seen that the maximum concentration results from the combination of lines 1, 2, and 3 but does not necessarily derive from the sum of the three independent maxima. This is due to differences in stack heights and emission rates. This means that a potentially critical receptor in one scenario may be safer in another scenario.

Three conservative scenarios were investigated to simulate the influence of production schedules. These were based on operational constraints where the maximum production can only be sustained for 16 hours. Eight hours are required for recovery. Then, three scenarios of 16 hour maximum production starting at 7 AM, 3 PM and 11 PM and allowing two 8 hour shifts separated by an 8 hour recovery periodwere selected. The results are presented in Figure 5.9.

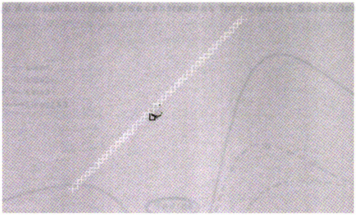


Figure 5.7 Selected Receptors for Sensitivity Analysis

Benzene Annual Average Concentrations for selected Scenarios-(1991)

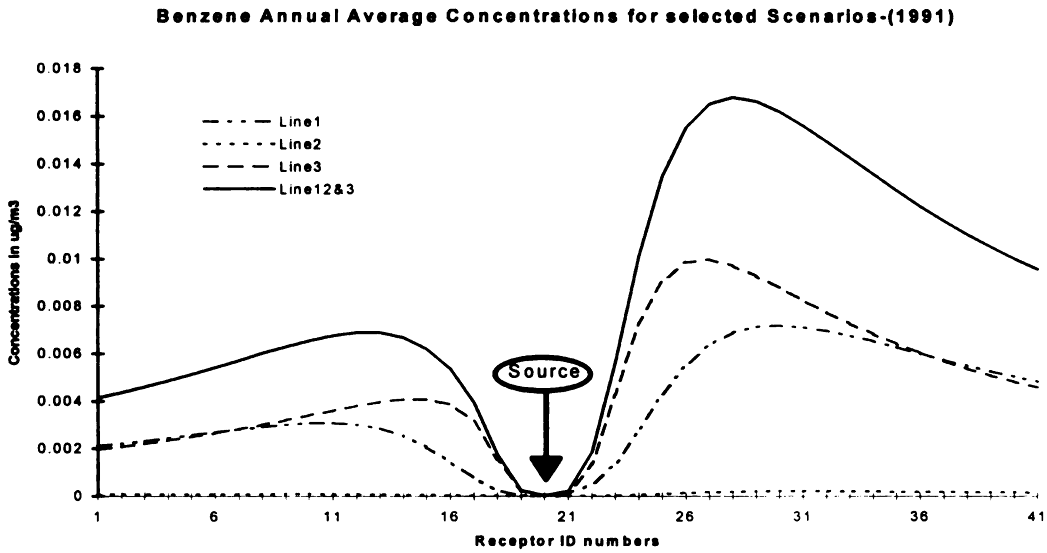


Figure 5.8 Annual average benzene profiles for full production for each line and all lines with 1991 meteorological data.

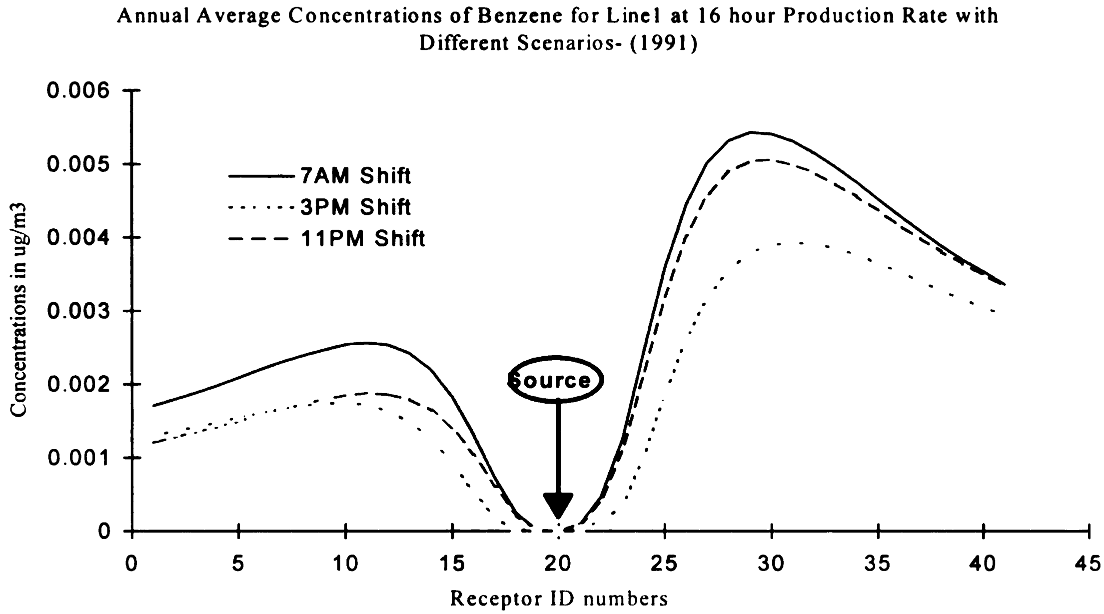


Figure 5.9. Annual average benzene concentrations in ($\mu g/m^3$) for 16 hour production for three operating schedules: 7AM-11PM, 3PM-7AM, 11PM-3PM.

This simulatio

ground level c

A more compr

shift at 4 PM w

30% reduction

As the sun beg

the inversion la

radiation has re

are, generally h

inversion layer

This effect inte

itself. This cou

the afternoon, s

dilution of the e

5.7.4 Sensiti
Increa

As one can expec

pollutant concentr

heights was simul

This simulation indicates that a 16 hour shift beginning at 3 PM would result in the lowest ground level concentrations.

A more comprehensive hour by hour shift on the start time revealed that starting the 16 hour shift at 4 PM would result in the lowest concentrations. Starting at 4 PM would result in a 30% reduction in the highest concentration observed on the 7 AM shift.

As the sun begins to heat the ground surface by mid-morning, wind speed increases, and the inversion layer built during the night breaks down. By early afternoon, the solar radiation has reached its maximum. The mixing height is extremely high and the winds are, generally high due to convection. At dusk, the ground begins to cool and an inversion layer begins to form. Due to reduced convection, the wind speed is very light. This effect intensifies as the ground cools further until sunrise when the process repeats itself. This could explain the lower concentrations observed in the scenarios starting in the afternoon, such as 3 and 4 PM. At this time the mixing height is large and favors the dilution of the emitted chemicals producing lower concentrations at the ground level.

5.7.4 Sensitivity of Exposure Concentrations to Stack Height Increase

As one can expect, an increase in stack height increases the dispersion and reduces the pollutant concentration at the ground level. As an example, a 15 foot increase in the stack heights was simulated with the 24 hour- maximum and the second highest production rates representing re

shown in Figu

A 15 foot incr

anticipated the

stack height de

5.8 Synthe

Based on thes

probabilistic e

emission rates

were determin

Cullen 1995).

constructed to

results with PD

receptors for th

representing respectively all the three lines together and Line 1 separately. The results are shown in Figure 5.10.

A 15 foot increase in the stack height, increased the stack height approximately 20%. As anticipated the concentration decreased about 30%. This implies that small changes in the stack height do not greatly influence the aerodynamic downwash effect of the building.

5.8 Synthesized PDF of Emission Rates

Based on these simulations and the need for probability distributions to develop a probabilistic exposure estimate, a probability distribution was synthesized to describe the emission rates compiled from stack sampling analysis. The mean and standard deviation were determined to build a distribution function (Finley, Proctor et al. 1994; Frey and Cullen 1995). Using Monte Carlo simulations, and a log-normal distribution, a PDF was constructed to describe the emission rate variability see Figure 5.11. Full concentration results with PDF characteristics (e.g., mean, and standard deviation) at the selected receptors for the chosen scenarios are in Appendix F.

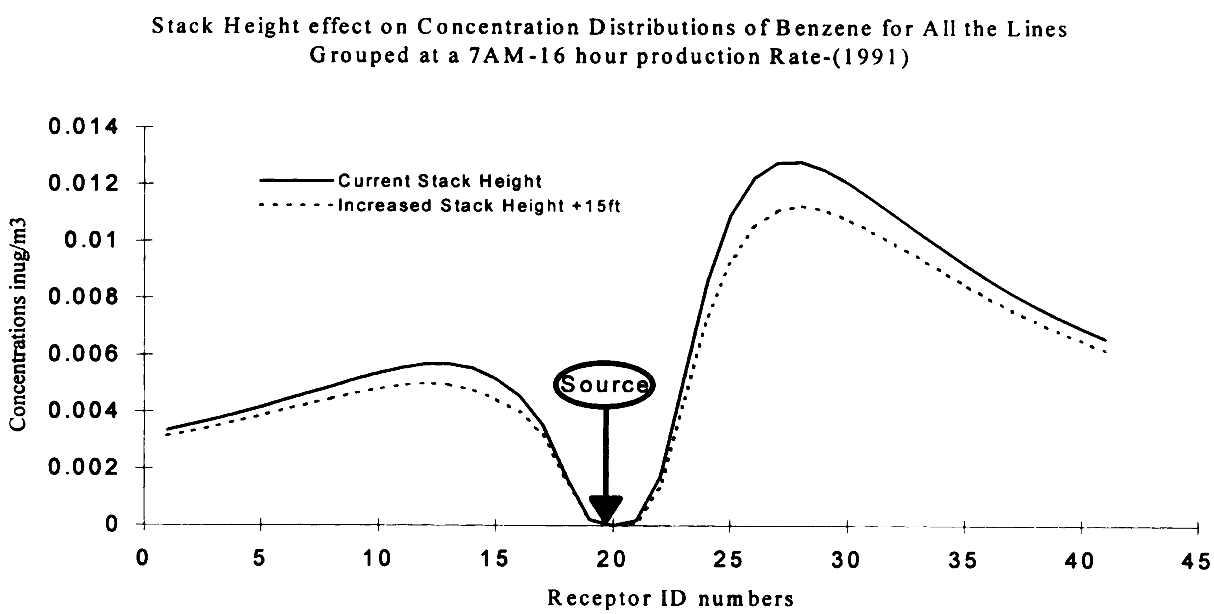


Figure 5.10 Sensitivity of average annual benzene concentrations in ($\mu g/m^3$) to stack height with 15 feet increase.

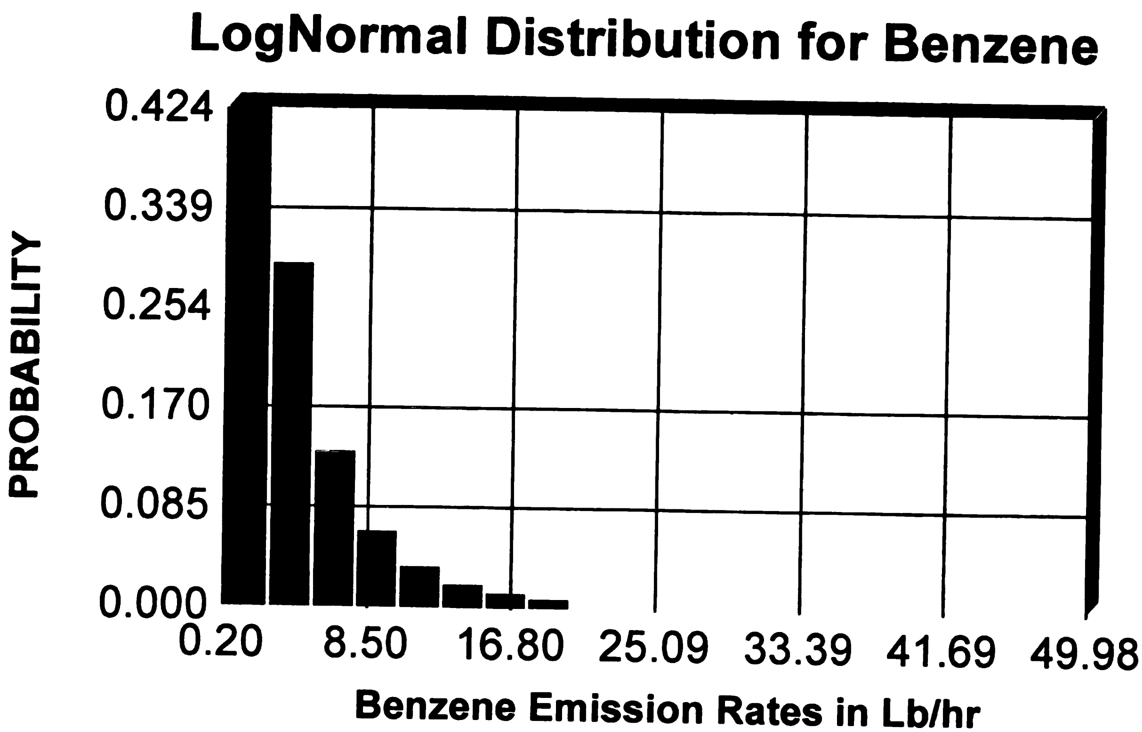


Figure 5.11 Probability Distribution for Measured Emission Rates.

Referenc

F.Pasquill, D
from

Finley, B., D
Freq

Frey, H. C.
Exp

Gratt, L. B.
Con
Ann

Paine, R. J.
89tl

Scott, W. D
Mo

Turner, D.
Dep

U.S.EPA (
Mo
Sta

U.S.EPA (
Mo

Venkatram
As
8: 1

References

F.Pasquill, D. S. (1962). Atmospheric Diffusion - The Dispersion of Wind-borne Material from Industrial and other Sources. London W.14, England.

Finley, B., D. Proctor, et al. (1994). "Recommended Distributions for Exposure Factors Frequently Used in Health Risk Assessment." Risk Analysis 14(4): 533-553.

Frey, H. C. and A. C. Cullen (1995). Distribution Development for Probabilistic Exposure Assessment. 88th Annual meeting 7 Exhibition, san Antonio, Texas.

Gratt, L. B. and L. Levin (1995). An Analysis of Dispersion Model Options in the Comprehensive Risk Evaluation of Electric Utility Air Toxic Emissions. 88th Annual Meeting & Exhibition, San Antonio, Texas.

Paine, R. J. (1996). Evaluation of Building Downwash Models with Several Data Bases. 89th Annual meeting & Exhibition, Nashville, Tennessee.

Scott, W. D., R. H. James, et al. (1976). "Foundry Air Contaminants from Green Sand Molds." American Industrial Hygiene Association: 335-343.

Turner, D. B. (1967). Workbook of Atmospheric Dispersion Estimates. Cincinnati, Ohio, Department of Health and Welfare.

U.S.EPA (1995). User's Guide for the Industrial Source Complex (ISC3) Dispersion Models. Research Triangle Park, NC., Office of Air Quality Planning and Standards.

U.S.EPA (1995). User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), EPA.

Venkatram, A. and C. Seigneur (1993). "Review of Mathematical Models for Health Risk Assessment:II. Atmospheric Chemical Concentrations." Environmental Software 8: 75-90.

Exposure a

contaminar

impact. Th

common ro

route will d

one or mor

6.1 The

The object

receptor. h

the recepto

particular

significant

Estimating

done in tw

has most o

However, s

Chapter 6

Exposure Assessment - Probabilistic Model

Exposure assessment is the translation of the transport and fate of environmental contaminants from their source or point of formation to the point of their biological impact. The human body can take up toxic chemicals through one or more of the three common routes: inhalation, dermal contact, and ingestion. The uptake by a particular route will depend essentially on the properties of the toxic chemical, its concentrations in one or more environmental media (air, water, and soil) and its human behavior.

6.1 Theoretical Background

The objective of an exposure assessment is to estimate how chemicals travel to a receptor, how those chemicals traverse epithelial barriers to gain entrance to the body of the receptor, and whether those chemicals present in the environmental medium at a particular concentration be present within a receptor at a level presumed to cause significant adverse effects (Finley and Paustenbach 1994; Finley, Proctor et al. 1994). Estimating the magnitude of exposure to those chemicals of potential concern can be done in two ways: the point estimate and the probabilistic assessment. To date , exposure has most often been calculated using point estimates recommended by the EPA. However, some scientists suggest that the probabilistic method over the point estimate approach is

disputes ov

measure of

6.1.1 Fu

Human exp

and food as

contacts wi

multiple m

The nature

human fact

The human

of an indivi

Important f

patterns, wl

activities ar

inhalation, i

outdoor env

approach is more appropriate because it provides more meaningful information, avoids disputes over the best point estimates, and associates the risk estimates with a quantitative measure of the uncertainty.

6.1.1 Fundamental Equations

Human exposure to chemicals can result from contact with contaminated soils, water, air, and food as well as with drugs and consumer products. Exposure may be dominated by contacts with chemicals in a single medium or may reflect concurrent contacts with multiple media.

The nature and the extent of multimedia exposures depends largely on two things: (1) human factors and (2) the concentrations of the chemical substance in the contact media. The human factors include all behavioral, sociological, and physiological characteristics of an individual that directly or indirectly affect the contact with the substance of concern. Important factors in this regard are contact rates with air, soil, and water. The activity patterns, which are defined by an individual's allocation of time spent at different activities and locations, are also significant because they directly affect the magnitude of inhalation, ingestion and dermal exposure to substances present in different indoor and outdoor environments.

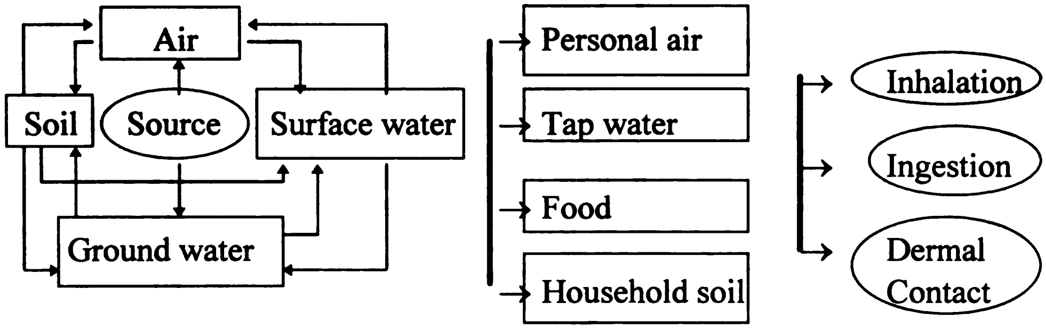
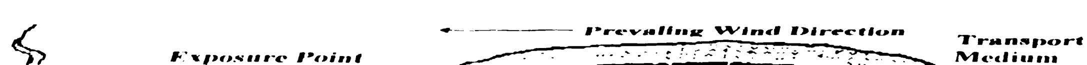


Figure 6.1. Potential interactions among source term, environmental media, exposure media, and exposure routes that must be addressed in multimedia, multiple pathway, exposure assessment.


Prevailing Wind Direction
Transport Medium
Exposure Point

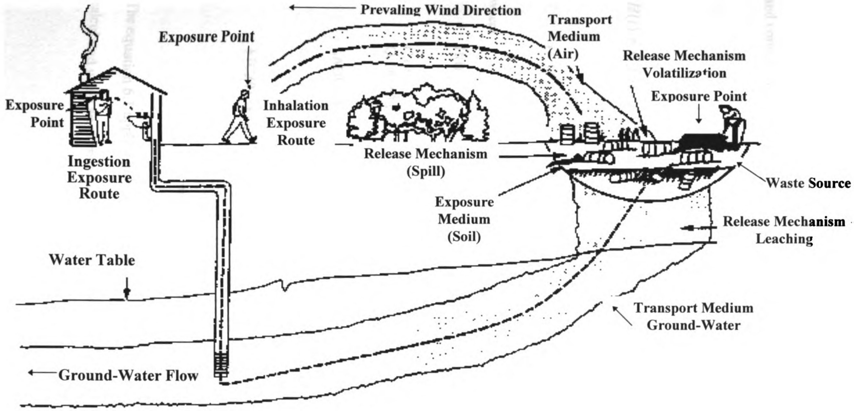


Figure 6.2. Illustration of Exposure Pathways

Based on th

total expos

and concen

$H(t) = C_s$

(6.1

where

H(t)

C_s(0

Q (

LAD

φ [C_s

The equatio

calculated us

Based on the logic illustrated in the Figure 6.1, and the pathway scheme in Figure 6.2, the total exposure can be constructed as a function of time, pathway, environmental medium, and concentration as follows:

$$H(t) = C_s(0) \times \left\{ \sum_{\substack{j \\ routes,}} \sum_{\substack{k \\ environ, \\ mental \\ media}} \sum_{\substack{i \\ exposure \\ media}} \left[Q_j(LADD_{ijk}) \times \left(\frac{LADD_{ijk}}{C_k} \right) \times \phi\left[C_s(0) \longrightarrow C_k(t) \right] \right] \right\}$$

(6.1)

where

$H(t)$	=	is the distribution of individual carcinogenic lifetime risk at some time t in the future within a population exposed for an exposure duration, ED, to a contaminant in a medium at an initial time zero
$C_s(0)$	=	the contaminant concentration in mg/m^3 measured at time zero
$Q_j\ (ADD_{ijk})$	=	is the dose-response function that relates the potential dose, ADD_{ijk}, by route j to the lifetime probability of detriment per individual within the population, mg/kg·d
$LADD_{ijk}/C_k$	=	the unit dose factor (average daily potential dose over a specific averaging time) from exposure medium i by route j (inhalation, ingestion, or dermal uptake) attributable to environmental department k divided by C_k when C_k is constant over the duration ED
$\phi\ [C_s(0) \rightarrow C_k(t)]$	=	the multimedia dispersion function converting the contaminant concentration $C_s(0)$ in mg/m^3 measured today, into contaminant concentration C_k at a time t in the future for a duration of exposure ED in environmental medium k (units of C_k are in mg/kg for soil, mg/m^3 for air, and mg/L for water).

The equation 6.1 applies only to carcinogenic compounds. Instead, a hazard Index is calculated using an average daily dose (see equation 8.3). The distribution of the individual do

environmenta

When an env

ED. the popu

($LADD_{jk}$)for

in mg kg.d by

$LADD_{ijk}$ or

Where

[C_r/C_k]

[IU_{ij} ·E

EF

ET

ED

AT

C_k

After a sensiti

likely to be fo

(USEPA, 199

mg kg d for in

individual dose is developed by summing the dose and effects over exposure routes, over environmental media, and over exposure pathways.

When an environmental concentration is assumed constant over the exposure duration, ED, the population-average potential dose is the lifetime average daily dose rate ($LADD_{jk}$)for carcinogens or average daily dose (ADD_{jk}) for non-carcinogens. It is given in mg/kg.d by:

$$LADD_{ijk} or ADD_{ijk} = \left[\frac{C_i}{C_k}\right] \cdot \left[\frac{IU_{ij}}{BW}\right] \cdot \frac{EF \cdot ET \cdot ED}{AT} \cdot C_k \tag{6.2}$$

Where

$[C_i/C_k]$	=	the intermedia-transfer ratio, which expresses the ratio of contaminant concentration in the exposure medium i to the concentration in an environmental medium k
$[IU_{ij}/BW]$	=	is the intake or uptake factor per unit body weight associated with the exposure medium i and route j such as m^3(air)/kg·hour
EF	=	is the exposure frequency for the exposed individual, in days per year
ET	=	is the exposure time in hours per day
ED	=	is the exposure duration for the exposed population in years
AT	=	is the averaging time for the exposed population, in days
C_k	=	is the contaminant concentration in the environmental medium k

After a sensitivity analysis, it was found that the foundry pollutants of concern are most likely to be found in the air; the percentage of their partition to the air is higher than 90% (USEPA, 1993). For a single medium, for example air, the average daily dose (ADD) in mg/kg·d for inhalation will be then calculated by the following equation (U.S.EPA 1989).

$LADD_{ijk}$ or

Where

C_{air}

IU_{air} B

EF

ET

ED

AT

Frequently, th

exposure dura

for dynamic c

exposure actu

description o

simplistic wi

dynamics.

Probabilistic

patterns at va

sensitive sub

simplified ma

6.1.2 "Poi

Historically, re

where a unique

$$LADD_{ijk} or ADD_{air} = C_{air} \cdot \left[\frac{IU_{air}}{BW}\right] \cdot \frac{EF \cdot ET \cdot ED}{AT} \tag{6.3}$$

Where

C_{air}	=	Contaminant concentration in the air, mg/m^3.
IU_{air}/BW	=	Intake factor by unit body weight of the exposure medium, $m^3/kg \cdot hr$.
EF	=	The exposure frequency of the individual, days/year.
ET	=	The exposure time, hours/day.
ED	=	The exposure duration for the exposed population, years.
AT	=	Averaging time for the exposed population, days.

Frequently, the environmental concentration C_{air} is considered constant over the exposure duration. A general limitation of the current models is that they do not account for dynamic concentration variations in microenvironmental control volumes in which the exposure actually occurs. Despite the level of sophistication with respect to the description of environmental fate and transport, most exposure models are relatively simplistic with respect to the description of the microenvironment and population dynamics.

Probabilistic exposure models account for population dynamics and human activity patterns at various level of sophistication, considering time-space distributions and sensitive subpopulations. Often these models treat exposure concentration dynamics in a simplified manner (Georgopoulos, Walia et al. 1996).

6.1.2 "Point Estimate" Approach to Exposure Assessment

Historically, regulatory decisions based on risk assessment used a point estimate approach, where a unique value was selected for each of the variables involved in the risk equation. In addition to

has the ad

knowledg

Paustenba

method ra

proper dis

reluctant t

assessmen

The pitfall

upper-bou

maximal e

unreasonab

individuals

majority of

which a sin

limited amo

Nevertheles

scenario of

6.1.3 Pr

In contrast w

complete cha

addition to the fact that it is readily accepted by state and federal regulatory agencies, it also has the advantage of being a straight forward calculation of the health risk that requires little knowledge about the scientific foundation of the different exposures (Finley and Paustenbach 1994). Two other major reasons drove decision makers to this conservative method rather than a probabilistic method. The first was the lack of consensus on the proper distributions for key exposure factors. In addition, regulatory agencies were reluctant to accept the probabilistic approach as a methodology for exposure and risk assessment due to the lack of guidance and policy (Finley, Proctor et al. 1994).

The pitfalls of the point estimate method are, however, numerous. The repeated use of upper-bound point estimates, as recommended by the U.S. EPA to determine a reasonable maximal exposure, leads typically to unrealistic estimates of health risk and most likely unreasonable clean-up goals. Because the resulting exposure estimate is applicable to individuals well above the intended 95th percentile, it is overly protective for the vast majority of the population. Another major disadvantage in the point estimate method in which a single value of the risk to the entire population is determined is that it provides a limited amount of useful information to the risk manager (Finley and Paustenbach 1994). Nevertheless, this method has the merit as an easy screening method to obtain a worst case scenario of a potentially exposed population.

6.1.3 Probabilistic Approach to Exposure Assessment

In contrast with the point estimate method, the probabilistic method will result in a more complete characterization of the exposure information available for decision-making.

The prob

uncertain

variance

degree of

additiona

A probab

a standard

recognitio

evaluatio

represent

a single n

of the pro

6.1.3.1

To perfor

"@RISK"

1997). @

Latin Hyp

distributio

simulation

both for co

The probabilistic approach offers the possibility of an associated quantitative measure of the uncertainty around the value of interest. A sensitivity analysis is also possible based on the variance determined from a probability distribution function (PDF). This will determine the degree of confidence with which the variables are known and will also indicate whether additional data are needed to increase reliability of the results.

A probabilistic approach means that decision-making is no longer based on a comparison of a standard desirable limit with a worst case undesirable value. It is instead based on a recognition of the most likely occurring value that should be given more weight in the evaluation process. In addition, a better understanding of the risk is provided by a graphical representation of the probability distribution describing the variables of interest. Instead of a single number assigned to the variable, the full range of possible values and some measure of the probability of occurrence of each value can be included.

6.1.3.1 Computational Methods for Estimating Dose PDFs

To perform the probabilistic exposure evaluation, a computer program (entitled "@RISK") that was developed to employ random sampling was implemented (Palisade 1997). @RISK provides two sampling techniques: Monte Carlo random sampling and Latin Hypercube random sampling. Both methods of generating ADD probability distribution functions (PDFs) were investigated. Despite the fact that Monte Carlo simulations are more widely used in this kind of practice, some runs were conducted with both for comparison. The Latin Hypercube method has two advantages. The first is that it forces s

distributi

will recre

without r

number c

converge

course, r

Simulati

stabilize

iteration

6.2 Se

An over

Exposur

Model (

exposure

mixtures

(RCDs).

ecosyste

multi-pa

pollutant

it forces sampling to represent values in each interval. By stratifying the input probability distribution into equal intervals in the cumulative probability scale (0 to 1.0), sampling will recreate the input probability distribution. Also, the technique used is "sampling without replacement". This means that the number of stratifications will equal the number of iterations so that no value can be considered twice. Second, this method converges to a stable outcome more quickly than the Monte Carlo method which, of course, means shorter run times.

Simulation results, in particular, the mean and the standard deviation of the outcome, stabilized after about 5,000 iterations. However, with Monte Carlo sampling, 10,000 iterations were required for convergence.

6.2 Selection of an Exposure Model

An overall total exposure assessment approach is being developed by the EPA's Risk and Exposure Assessment Group (REAG). It has been designated as the Total Risk Integrated Model (TRIM). A complete residual risk evaluation will include short-term acute exposure from air and non-air sources, urban area toxic exposures from pollutant mixtures, and use of explicit dose estimates as alternatives to the Reference Doses (RfDs). This model will be capable of assessing risks to both humans and sensitive ecosystems resulting from multimedia contamination in air, water, soil, and food and multi-pathway exposure via inhalation, ingestion, and absorption exposure routes to pollutants of concern.

6.2.1 R

In 1995, i

were four

was narro

-
-
-
-

The two

-

-

IEM2 w

exposur

On the c

surpasse

develope

dispersio

without

6.2.1 Review of Existing Models

In 1995, investigations of EPA and non-EPA approaches were made. Only two models were found to have sufficient capabilities for potential use by TRIM. The list of models was narrowed based on the following factors:

- availability of distributional data for input parameters;
- distinction between environmental concentrations and exposure concentrations;
- use of human activity and microenvironmental data; and
- consideration of uncertainty in a systematic fashion.

The two models retained for more in-depth evaluation and comparison are :

- EPA's multimedia risk methodology, the Indirect Exposure Methodology (IEM2) with an addendum completed in 1993; and
- California Department of Toxic Substance Control's multimedia risk computerized model, CalTOX updated in 1995, with continual enhancement underway.

IEM2 was retained primarily because it represents current EPA choice for indirect exposure assessment, and so any other model selected should at least be compared to it. On the other hand, CalTOX was retained as the model-of-choice, primarily because it surpassed all other models reviewed in a level of sophistication. In addition to that, the developer of CalTOX claims that sophisticated regional atmospheric dispersion/deposition models such as ISC3-ST and LT could be added to CalTOX without much difficulty.

CalTOX, a

includes tv

with the a

air, surfac

exposure

contact m

in the po

6.2.2 S

The defa

exposure

investiga

the haza

their hig

contribu

chemica

route as

thoroug

CalTOX, an overall model for multimedia, multiple pathway exposure assessment, includes twenty-three potential exposure pathway scenarios. CalTOX analysis begins with the assumption that through modeling or measurement, concentrations for ambient air, surface water, ground water, surface soil, and root-zone soil can be determined. The exposure assessment process consists of relating contaminant concentrations in the contact media (personal air, tap water, foods, household dusts and soil, etc.) to the intake in the population of concern.

6.2.2 Sensitivity Analysis

The default values provided in CalTOX were used to asess multimedia multiple pathway exposure from the compounds of interest released from the casting resins. The investigation showed that there was no need to consider multimedia exposure models for the hazardous air pollutants. Due to their chemical and physical properties, in particular their high volatility, the inhalation route was predominant in terms of its major contribution in the intake values. This was mostly due to the high partitioning of these chemicals to the air. Figure 6.3, based on a multi media, multiple pathway, and multiple route assessment, indicates where it is most valuable to focus research resources to more thoroughly characterize distributions of population exposure.

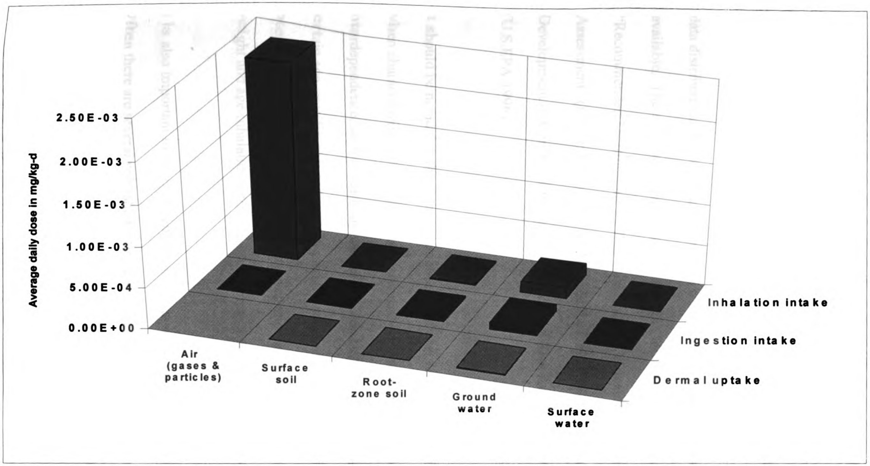


Figure 6.3. Desegregation by exposure route and by exposure medium of the average daily dose of exposure to hazardous air pollutants in the foundry

6.3 R

The pr

calcula

Howe

data d

availa

"Rec

Asse

Deve

(U.S

It sh

whe

inte

cert

inte

wei

It i

Off

acc

obj

6.3 Review of Probability Distribution Function (PDF)

The probabilistic approach to exposure assessment involves performing iterative calculations using probability distributions of each of the appropriate exposure factors. However, a major problem with probabilistic modeling is the agreement upon "standard" data distributions. Since this is a relatively new practice there is limited information available. There are several suggestions, though , including those published in "Recommended Distributions for Exposure Factors Frequently Used in Health Risk Assessment" (Finley, Proctor et al. 1994) and the Ohio EPA's "Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures" (U.S.EPA 1996).

It should be noted that there are a number of technical issues that should be addressed when characterizing a "standard" distribution. One of these issues is factor interdependence, such as for body weight and skin surface area. To minimize errors, certain age-specific distributions are used to account for these (Lioy 1990). The only interdependence between exposure factors considered in this research are age-body weight and age-inhalation rates. All other parameters are assumed to be independent.

It is also important to select the appropriate data set(s) for characterizing a distribution. Often there are several published estimates that differ widely in data quality, credibility, accuracy, collection/analysis techniques, measured end points, and data collection objectives (Lioy 1990).

6.3.1 Co

Contamina

Complex S

account me

buildings w

Since ISC3

emission ra

Hence, hou

functions o

output. Ba

fitted to a lo

is presented

6.3.2 Inh

IR is depend

given in m^3/

Detailed ana

6.3.1 Contaminant Concentration in Air (C_{air})

Contaminant concentration in air is chemical and scenario specific. The industrial Source Complex Short Term air dispersion model along with annual emission rates takes into account meteorological conditions, source type, geography, and the effects of nearby buildings when estimating airborne concentrations (Copeland, Holbrow et al. 1994).

Since ISC3 was not developed to introduce emission rates as an explicit function of time, emission rate variability determinations were possible only from one hour to another. Hence, hourly-averaged emission rates were used and no generation of distribution functions of the predicted concentrations at the receptors was possible from the ISC3 output. Based on an analysis of the variability of emissions (Chapter 5) the C_{air} data were fitted to a log-normal distribution. A graphical illustration of an example of this behavior is presented in Figure 6.9. Detailed results for all scenarios are shown in Appendix F.

6.3.2 Inhalation Rate IR or (IU_{air})

IR is dependent on the activity being performed. It is described by inhalation rates that are given in m^3/day. Some examples of proposed PDFs are shown in Table 6.1 and 6.2. Detailed analysis of some of the existing PDFs is offered in Appendix H.

Table 6.1 Selected Cumulative Distribution Percentiles of Inhalation Rates in m^3/day by Age (Finley, Proctor et al. 1994)

	Percentile (m^3/day)							
Age (yr.)	5th	10th	25th	50th	75th	90th	95th	99th
<3	3.3	3.6	4.1	4.7	5.5	6.2	6.7	7.8
3-10	6.1	6.5	7.3	8.4	9.7	10.9	11.8	13.8
10-18	9.1	9.8	11.2	13.1	15.3	17.7	19.3	22.5
18-30	10.5	11.3	12.8	14.8	17.1	19.5	21.0	24.6
30-60	8.4	9.1	10.2	11.8	13.6	15.4	16.7	19.2
<60	8.5	9.2	12.4	11.9	13.7	15.6	16.7	19.6

Table 6.2 Probability Density Functions for Inhalation Rates (U.S.EPA 1996)

Pathway	Distribution	Mean	SD	Min.	Max.
Inhalation Rate (m3/hr) Residential Adult	Triangular	0.80	-	0.52	1.02
Inhalation Rate (m3/hr) Residential Child	Triangular	0.47	1.8	0.38	0.56

6.3.3

EF is s

EF is n

recomn

EI

These

differe

part-ti

the US

Depar

E

For re

EF

and

EF

This d

an adu

assume

6.3.3 Exposure Frequency (EF)

EF is site- and scenario-specific. It could be influenced by season, activity and age. The EF is measured in units of days per year, or events per year. For example, the PDF recommended by the Ohio EPA for commercial land use is: (U.S.EPA 1996)

EF_{work} ~ Triangular[Min = 125 d/yr, Likeliest value = 214 d/yr, Max = 290 d/yr]

These parameters are defined by a triangular distribution based on the climate patterns in different regions of Ohio, and assumptions about vacation leave, sick leave, holidays, and part-time/full-time status of workers. This distribution will not be the same in all parts of the US due to different weather conditions affecting exposure. For instance, the Oregon Department Environmental Quality adopted different distributions. These were :

EF_{work} ~ Triangular[Min = 125 d/yr, Likeliest value = 214 d/yr, Max = 290 d/yr]

For residential land use, two EF distributions were given by the Ohio EPA:

$EF_{residential}$ ~ Triangular[Min = 323 d/yr, Likeliest value = 351 d/yr, Max = 365 d/yr]

and

$EF_{residential}$ ~ Triangular[Min = 261 d/yr, Likeliest value = 330 d/yr, Max = 365 d/yr]

This distribution based upon best professional judgment assumes a maximum value for an adult/child receptor to be home every day of the year. However, the Oregon DEQ assumes:

$EF_{residential}$ ~ Uniform[Min = 50 week/yr, Max = 52 week/yr]

Finley ar

EF distri

constant

with the

Californ

minimur

ingestion

in all pa

For the

different

climate

6.3.4

ET is de

measure

of distrib

- Va

  res

  ET

Finley and Paustenbach (Finley and Paustenbach 1994) do not recommend a "standard' EF distribution. In the three case studies involving air, water, and soil, they proposed a constant EF value of 350 days. This is an upper bound point estimate that is in agreement with the U.S. EPA.

California's approach to EF is a uniform distribution with a maximum value of 1 and a minimum value of 0.58. They define EF as a fraction of a year as used in inhalation, soil ingestion, and dermal absorption pathways. Again, this would not be a good assumption in all parts of the United States based on climate differences.

For the purpose of this study, a central tendency was adopted. A simulated average of the different distributions recommended by the Ohio EPA was implemented based on the climate similarities with the region of Michigan.

6.3.4 Exposure Time (ET)

ET is defined by an hour per day or hour per event that a person is exposed. It is measured as by time spent in shower, bathroom, household, or at work. Some examples of distribution that can be used are:

- Values defined by a custom distribution based on the assumption that some residents spend 8 hr/d at work, reducing the time spent at home:

$ET_{household}$ = uniform, minimum value of 8 hr/d, maximum value of 20 hr/d, arithmetic mean of 14 (McKone and Bogen 1992; Finley, Proctor et al. 1994);

E

E

•

E

•

•

The E

intend

6.3.5

Expos

examp

reside

$ET_{residential\text{-}adult}$ = 50 percent probability: 16 hr/d, 50 percent probability: 24 hr/d;

$ET_{residential\text{-}child}$ = 25 percent probability: 16 hr/d, 75 percent probability: 24hr/d (U.S.EPA 1996).

- A custom distribution based on the assumption that children may spend 8 hr/d away from home.

$ET_{commercial}$ = minimum value of 4 hr/d, likeliest value of 8hr/d, maximum value of 12 hr/d (U.S.EPA 1996).

- A triangular distribution based on best professional judgment.

$ET_{industrial}$ = 0.90 relative frequency: 8 hr/d, 0.10 relative frequency: 9-12hr/d (U.S.EPA 1996).

- A custom distribution based on best professional judgment and the assumption that most industrial workers are at the property for 8 hr/d and 10% are present as long as 12 hr/d.

The $ET_{household}$, was used for calculations to focus on residential health risk as it was intended in the scope of this study.

6.3.5 Exposure Duration (ED)

Exposure duration will vary with each different scenario and pathway of exposure. For example, ED for a residential-adult is a custom probability distribution based on residency occupancy periods. The PDF's for Ohio are listed below (U.S.EPA 1996).

The expo

derived f

all work

6.3.6 E

There hav

distributi

distributio

0
1.
5
12

Another E

describes

13.49 kg.

The Ohio I

adult men

The exposure duration values for the commercial/industrial land use scenario were derived from a Bureau of Labor Statistics survey using workers that are 25 and older in all work categories and are as follows:

Year at One Job	Relative Probability
1	0.209
2 to 5	0.317
6 to 9	0.134
10 to 14	0.14
15 to 19	0.08
20 to 40	0.12

6.3.6 Body Weight (BW)

There have been several recommended distributions for the body weight factor. One such distribution was described by Copeland et al [Copeland, 1993 #193] as a normal distribution with the following parameters:

0 -1.5 year	Mean = 10 kg	SD = 0.12
1.5 - 5 year	Mean = 14 kg	SD = 0.13
5 - 12 year	Mean = 26 kg	SD = 0.75
12 - 70 year	Mean = 62 kg	SD = 0.30

Another BW distribution from the same author, (Copeland, Paustenbach et al. 1993) describes BW as a normal distribution with a mean of 62.4 kg and a standard deviation of 13.49 kg.

The Ohio EPA defines BW as a normal distribution for an equal population of residential adult men and women, with an arithmetic mean of 71 kg and a standard deviation of 15.9

kg. The

weigh les

normal d

15 kg wit

On the ot

recommen

Each of th

However,

"standard

the future.

6.3.7 A

According

Scott et al.

equal to E

(70 yrs × 3

children an

Scott et al.

kg. The minimum body weight was set at 32 kg to account for elderly residents who may weigh less than other adults considered. The residential child BW is described by a normal distribution for an equal population of male and female children with a mean of 15 kg with a standard deviation of 1.95 kg (U.S.EPA 1996).

On the other hand, Finley, Proctor, and Scott, Harrington, Paustenbach, and Price recommend the BW distribution shown in Table 6.3 (Finley, Proctor et al. 1994).

Each of these distributions is very similar, differing only by a factor of about 4 kg. However, for a conservative approach, the Ohio EPA's distribution is recommended for "standard" use since it tends to agree with other studies and will most likely be adopted in the future. Review of a second study can be examined in Appendix H.

6.3.7 Averaging Time (AT)

According to the U.S.EPA (U.S.EPA 1989) and Finley, Scott and Paustenbach (Finley, Scott et al. 1993), AT is specific to each exposure scenario. For non-carcinogens it is equal to ED × 365 d/y. For carcinogens AT is represented by a point value of 25550 days (70 yrs × 365 d/yr). This is a very conservative estimate because it is assumed that both children and adults are exposed to the contaminant 365 days per year for 70 years (Finley, Scott et al. 1993).

Table 6.3 Summary of Distribution Factors for Body Weight by Age and Gender

Age (yr.)	Gender	Mean (kg)	SD(kg)
0.5-1	Both	9.4	1.2
1-2	Both	11.8	1.4
2-3	Both	13.6	1.6
3-4	Both	15.7	1.7
4-5	Both	17.8	2.3
5-6	Both	20.1	2.8
6-7	Both	23.1	3.5
7-8	Both	25.1	3.8
8-9	Both	28.4	5.2
9-10	Both	31.3	5.0
10-11	Both	37.0	7.5
11-12	Both	41.3	10.5
12-13	Both	44.9	10.0
13-14	Both	49.5	10.5
14-15	Both	56.6	10.3
15-16	Both	60.5	9.7
16-17	Both	67.7	11.6
17-18	Both	67.0	11.5
>18	Men	78.7	13.5
>18	Women	65.4	15.3
>18	Both	71.0	15.9

6.4 S

The re

Desp

PDF

func

dail

EPA

at

sho

6.4 Selection of PDFs

The recommended distributions selected were chosen using the following criteria:

- consistency with other studies
- derivation of the distribution from a survey population representative of the general population,
- minimization of confounding variables, and sufficient data to reasonably characterize the variability and extremes of the distribution.

Despite the lack of consensus on the proper distributions for key exposure factors, the PDFs illustrated graphically in Figures 6.4 to 6.8 was selected. These distribution functions, for the different parameters affecting the intake value or precisely the average daily dose (ADD_{air}) were chosen based on advice from several experts in the field (e.g., EPA office experts in Washington DC., Dr. M. Kamrin from the Institute of Toxicology at Michigan State University). They may be introduced into the exposure calculations as shown in Table 6.4.

Table 6.4 PDFs for Exposure Factors

Exposure Factors for Men	**Probability Distribution Functions**					**Reference**
	Max.	**Mean/Mode/StDev**	**Min.**	**95%**	**Shape**	
Inhalation Rate in [m3/hr]	44.88	14.02/15.6/4.40	9.63	18.24	Discrete	(1,2)
Body Weight in [kg]	93.84	60.50/59.65/9.70	27.55	76.37	Normal	(1,2)
Exposure Frequency in [days/yr.]	364.94	288.35/278.39/44.25	211.82	357.19	Discrete	(2)
Exposure Duration in [years]	40	12.3/3.5/12.24	1	40	Discrete	(2)
Exposure Time in [hr./day]	24	20/16/4	16	24	DisUnif.	(2,3)

(1): Jurczyk, 1995; (2): Finley, 1994; (3):U.S.EPA, 1991

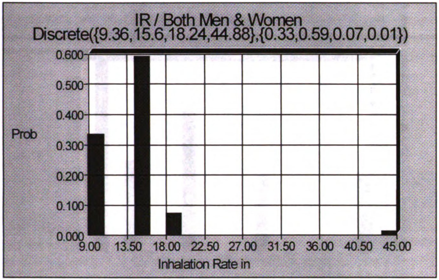


Figure 6.4 PDF for Inhalation Rates in m^3/hr

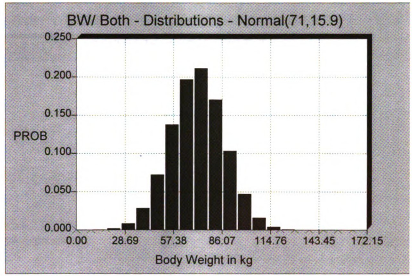


Figure 6.5 PDF for Body Weight

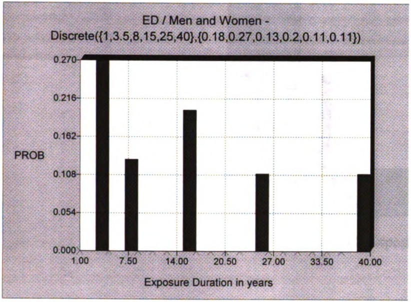


Figure 6.6 Exposure Duration in years

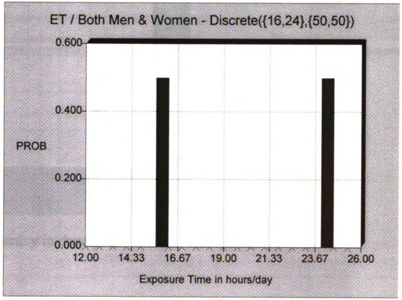


Figure 6.7 Exposure Time in hours/day

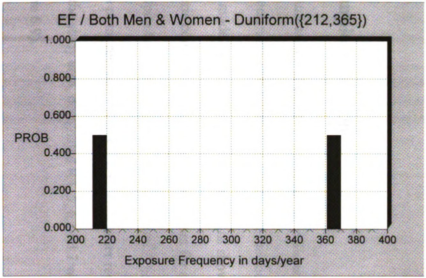


Figure 6.8 Exposure Frequency in days/year

6.5 I

The m

mean

expos

1996

intere

6.5.1

The c

two k

transp

atmos

1991)

center

limits

(see F

The pr

toluen

rates.

charac

6.5 Exposure Assessment

The need for using explicit time profiles of exposure concentrations in order to calculate meaningful estimates of biologically effective doses rather than average or cumulative exposures has been stated and justified by Smith (Smith 1992; Georgopoulos, Walia et al. 1996). These distributions were picked for the best possible fit to our population of interest and to realistically simulate the case study conditions.

6.5.1 Implementation

The concentrations of emitted hazardous air pollutants in the air in a surrounding area of two kilometers on two kilometers centered at the source were estimated using the transport model (chapter 5). These simulations showed three critical zones of high atmospheric concentrations that were persistent for a period of five years (from 1987 to 1991) despite the meteorological data variation. These three zones are designated by their centers as point receptors R1, R2, R3. Four other receptors at each corner of the physical limits of the study area, designated R4, 5, 6, and 7 were specified for control purposes (see Figure 6.9).

The predicted concentrations for selected chemicals (benzene, formaldehyde, phenol, toluene, and xylene) were calculated for different scenarios based on real production rates. Their variations were fitted to log-normal distributions that are statistically characterized in Table 6.5.

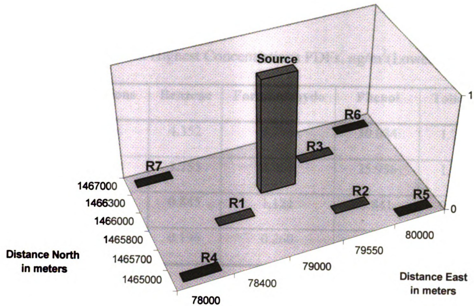


Figure 6.9 Receptor IDs and Locations

Table 6.5 Predicted First Highest Concentrations PDFs, μg/m^3(Lowest Scenario-4PM/91)

Receptor Designations		Benzene	Formaldehyde	Phenol	Toluene	Xylene
R3	Max	4.352	5.775	30.084	1.759	1.076
	Mean	3.755	4.983	25.956	1.518	0.929
	SD	0.845	1.121	5.841	0.341	0.209
	Min	0.196	0.260	1.354	0.079	0.048

6.5.2

Intake e

Investig

lowest a

binders

results a

characte

Based or

predicted

6.5.2 Intake Results

Intake evaluation for deifferent populations was performed for all the selected receptors. Investigation of different scenarios at different starting times were done to determine the lowest average daily dose. Simultaneously, evaluations were performed on eleven resin binders as comparisons for the binder system used in the case study (see Table 6.6). All results are illustrated in Appendix I. These are further used in Chapter 8 for risk characterization.

Based on the dispersion results of chapter 5, the receptor R3 exhibited the highest predicted concentrations. Therefore, it was targeted in most of the investigations.

Table

Case S
Phenol
Phenol
Phenol
Green S
Core oi
Shell
Low Ni
Med. N
Furan F
Alkyl Is
Sodium

Table 6.6 Predicted First Highest Concentrations in ug/m^3 at R3 for Alternate Resin Binders.

Conc. of Benzene in μg/m^3	**Receptor R3**				
	Benzene	**Formaldehyde**	**Phenol**	**Toluene**	**Xylene**
Case Study Resin Binder	**3.755**	**4.982**	**25.957**	**1.518**	**0.196**
Phenolic NoBake	30.025	0.027	2.612	1.698	0.260
Phenolic Urethane	14.334	0.059	10.457	2.231	1.176
Phenolic HotBox	2.684	0.016	10.457	0.487	0.324
Green Sand	1.637	0.011	0.351	0.169	0.056
Core oil	6.279	0.257	0.153	1.280	0.640
Shell	17.859	0.094	6.579	7.519	1.567
Low Nitrogen Furan	1.736	0.715	0.064	0.324	5.965
Med. Nitrogen Furan-TSA	12.145	0.174	0.270	23.642	0.651
Furan HotBox	1.438	0.024	0.043	0.086	0.086
Alkyl Isocynate	14.293	0.284	0.005	0.068	6.756
Sodium Silicate-Ester	3.777	0.453	0.731	0.755	0.252

Refe

Copel

Copel

Finley

Finley

Finley

Georg

Lioy, I

McKo

Palisa

U.S.EI

U.S.EI

U.S.EI

References

Copeland, T. L., A. M. Holbrow, et al. (1994). "Use of Probabilistic Methods to understand the Conservatism in California's Approach to Assessing Health Risks Posed by Air Contaminants." Air & Waste Management Association 44(December): 1399-1413.

Copeland, T. L., D. Paustenbach, et al. (1993). "Comparing the Results of a Monte Carlo Analyis with the EPA's Reasonable Maximum Exposed Individual (RMEI): A Case Study of a Former Wood Trestment Site." Regulatory Toxicology and Pharmacology(18): 275-312.

Finley, B. and D. Paustenbach (1994). "The Benefits of Probabilistic Exposure Assessment: Three Case Studies Involving Contaminated Air, Water, and Soil." Risk Analysis 14(1): 53-73.

Finley, B., D. Proctor, et al. (1994). "Recommended Distributions for Exposure Factors Frequently Used in Health Risk Assessment." Risk Analysis 14(4): 533-553.

Finley, B. L., P. Scott, et al. (1993). "Evaluating the Adequacy of Maximum Contaminant Levels as Health-Protective Cleanup Goals: An Analysis Based on Monte Carlo Techniques." Regulatory Toxicology an Pharmacology 18: 438-455.

Georgopoulos, P. G., A. Walia, et al. (1996). "Integrated Exposure and Dose Modeling and Analysis System. 1. Formulation and Testing of Microenvironmental and Pharmacokinetic Components." Enviro. Science & Technology 31(1): 17-27.

Lioy, P. J. (1990). "Assessing total human exposure to contaminants." Environ. Sci. Technol. 24(7): 938-945.

McKone, T. and K. Bogen (1992). "Uncertainty in Health Risk Assessment: An Integrated Case Study Based on Tetrachloroethylene in California Groundwater." Regulatory Toxicological Pharmacology 15: 86-103.

Palisade (1997). @RISK. Newfield, NY, Palisade Corporation.
Smith, T. J. (1992). American Journal Ind. Med.(21): 35-51.

U.S.EPA (1989). Risk Assessment Guidance for Superfund - Human Health Evaluation Manual. Washington DC., EPA.

U.S.EPA (1993). CalTOX, A Multimedia Total Exposure Model for Hazardous-Waste Sites. Sacramento, California. Ca EPA.

U.S.EPA (1996). Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures. Ohio, Ohio EPA.

In th

man

the c

vola

oper

benz

selec

their

7.1

The

inclu

orga

pulm

(Hay

after

Chapter 7

Toxicity Assessment

In the process of selecting the pollutants of concern for the case study, different manufacturing processes were explored, and it was found that the binders used to form the cores and the molds for the casting operation were the major source of the most volatile hazardous air pollutants. Based on the data available and discussions with the operating personnel, five compounds were selected for investigation. These were benzene, formaldehyde, phenol, toluene, and xylene. Benzene and formaldehyde were selected based on their carcinogenicity and abundance. The rest were chosen based on their non-carcinogenic toxicity and abundance.

7.1 Inhalation Toxicology

The potential toxic effects that need to be considered following inhalation exposure include irritation of the respiratory tract, behavioral changes, pathologic change to vital organs or tissues within and distal to the respiratory tract, immune system responses, pulmonary function alterations, metabolic disturbances; carcinogenicity, and even death (Hayes 1994). Studies to measure the effects of chemical agents on the biological system after entering the respiratory tract must follow carefully designed protocols. Regulatory agenc

inhala

EPA,

and th

standa

Reprod

species

to rela

chemic

animal

Theref

chemic

leads to

7.2 Sc

A review

documen

(Wexler

•

agencies have adopted standardized protocols for both short-term and long-term inhalation testing. Different regulatory institutions all over the world, such as the U.S. EPA, the organization for European Economic Cooperation and Development (OECD), and the Japanese Ministry of Agriculture, Forest and Fisheries (MAFF) have agreed on standardized protocols (Hayes 1994).

Reproducing, experimentally, the atmosphere in a form that can be inhaled by a test species requires very sophisticated equipment. In addition to that, it is inherently difficult to relate the inhaled dose to the retained one. The total dose depends on the physical and chemical properties of the compound, the physiological characteristics of the tested animal, and the numerous factors involved in deposition and clearance in the lungs. Therefore, it is very difficult, if not impossible, to find consistent research results for all chemicals. In addition to quality issues, the need to study a huge number of chemicals leads to deficiencies in the amount of pertinent toxicological data.

7.2 Sources of Toxicological Data

A review of different databases revealed a large number of on-line resources, and written documentation. Among the sources available, the following are always highlighted (Wexler 1995):

- TOXNET (the Toxicology Data Network developed by the National Library of Medicine's Toxicology and Environmental health Information Program in 1985 as an expansion of the former Toxicology Data Bank TDB) covers the broad areas of toxicology, hazardous chemicals, and the environment;

The Ir

consic

postec

to the

The re

- ATSDR (Agency for Toxic Substances and Disease Registry) provides information about toxic chemicals including their classification, and a summary of research results; and

- IRIS (Integrated Risk Information System) contains an EPA file with data related to carcinogenicity and non-carcinogenic risk assessment, including oral reference doses (RfDs), inhalation reference concentrations (RfCs), and cancer slope factors and unit risks.

The Integrated Risk Information System (IRIS) presents the most reliable source. It is considered a starting point in the risk assessment data sources hierarchy. IRIS updates are posted by EPA on a monthly basis. Gaps are, however, observed in some of the data due to the lack of studies and inconsistency of results.

The results of the toxicity data search are summarized in Table 7.1 for the selected HAPs.

Table 7.1 Listed toxicity data

Designations		Carcinogenic effects		Noncarcinogenic effects	
HAPs	**Class**	**Oral slope factor $(mg/kg\text{-}day)^{-1}$**	**Inhalation slope factor $(mg/kg\text{-}day)^{-1}$**	**Oral RfD mg/kg-day**	**Inhalation RfD mg/kg-day**
Benzene	A1	2.7E-00[2]	2.9E-02[2]*		
Formaldehyde	B1	5.0E-00[2]	4.6E-02[1,2]		
Phenol	D			6.0E-01[1,2]	NA
Toluene	D			2.0E-01[1,2]	1.2E-01[2] 2.0E-00[1]
Xylene	D			2.0E-00[1,2]	3.0E-01[1]*

*: under review; (1): Federal Register 1990; (2) recent IRIS data base.

7.3

In the

selec

The r

depre

erythr

Som

expos

in wo

1991;

Basec

Healt

huma

conta

necro

The e

ingest

anima

7.3 Adverse Effects

In the following paragraphs, the adverse effects (non-cancerous) of the five compounds selected for study are summarized.

The major systemic effect associated with chronic benzene exposure in humans is depression of bone marrow resulting in pancytopenia, which is a decrease in numbers of erythrocytes, leukocytes and thrombocytes, sometimes progressing to aplastic anemia. Some evidence of impaired immune system is observed in humans who have been exposed to chronically. Decreased serum complement, IgG, and IgA, levels were found in workers exposed to benzene, IgM level was slightly higher (Calabrese and Kenyon 1991; U.S.EPA 1994).

Based on the Agency for Toxic Substances and Diseases Registry (ATSDR) Public Health Statement, formaldehyde is an irritant to the skin, eyes and mucous membranes in humans. At high concentrations, it may cause bronchitis, pneumonia or laryngitis. Skin contact can lead to whitening and anesthetic effects due to superficial coagulation necrosis (Calabrese and Kenyon 1991; U.S.EPA 1994).

The effects on inhalation of phenol by humans are unknown. However, when it is ingested in food or water it produces diarrhea and mouth sores in humans. Laboratory animal experiments yielded effects such as muscle tremors and loss of coordination. At highe

injur

and I

Shor

skin.

prima

coor

Very

eyes.

vomi

1994

7.4

Benz

Muta

chron

noted

becau

repro

higher concentrations for longer periods of time, exposure resulted in paralysis and severe injury to the heart, kidney, liver, and sometimes the lungs, followed by death (Calabrese and Kenyon 1991; U.S.EPA 1994).

Short term exposure to toluene at high concentrations is associated with irritation of the skin, nose, and throat, difficulty in breathing, and impaired function of the lungs. The primary target is the nervous system and symptoms include headaches, lack of coordination and loss of balance (Calabrese and Kenyon 1991; U.S.EPA 1994).

Very limited data are available on xylene. At 200 ppm, xylene is a definite irritant of the eyes, nose, and throat. At higher concentrations pulmonary edema, anorexia, nausea, vomiting, and abdominal pain are observed (Calabrese and Kenyon 1991; U.S.EPA 1994).

7.4 Carcinogenicity

Benzene is a known human carcinogen, under the EPA weight-of-evidence classification. Mutagenicity of benzene is observed in both humans and animals. It induces chromosomal aberration in bone marrow cells and peripheral lymphocytes. Benzene was noted as genotoxic and fetotoxic at doses that are also maternally toxic. However, because of limited data, the ATSDR stated that there is not sufficient evidence to show reproductive effects result from exposure to benzene. In epidemiological studies of pe

ob

Fo

cla

abe

DN

feto

inha

rare

how

Ken

Phen

muta

effec

phen

assoc

Tolue

Altho

pregn

people exposed primarily to benzene, statistically significant excesses of leukemia were observed (Calabrese and Kenyon 1991; ATSDR 1992).

Formaldehyde is a probable human carcinogen under the EPA weight-of-evidence classification. It is a mutagen but requires bioactivation. It causes chromosomal aberrations and forms adduct with DNA and protein in vivo and vitro. It also inhibits DNA repair in cultured human cells. Although no evidence of teratogenicity is reported, fetotoxicity in rodents resulted from inhalation exposure. It is carcinogenic via the inhalation route in experimental animals based on the nasal squamous cell carcinomas (a rare tumor type) in both sexes of F344 rats, multiple rat strains, and mice. Generally, however, tumors were not observed beyond the initial site of nasal contact (Calabrese and Kenyon 1991, Stine, 1996 #304).

Phenol is not classified a carcinogen in the EPA weight-of-evidence classification. It is a mutagen that most likely acts on DNA synthesis, replication and repair. Non-teratogenic effects were reported, including a decrease in fetal weight due to maternal exposure to phenol. Cancer was produced in animals through the skin route but it has not been associated with cancer in humans (Calabrese and Kenyon 1991).

Toluene is not classified a carcinogen in the EPA weight-of-evidence classification. Although, studies in animals suggest, it may produce adverse effects in the fetus in pregnant women. Exposure of animals to high concentrations have resulted in increased fetal

howe

Xyle

assoc

whet

terat

activ

7.5

No n

(LO.

10 p

Keny

At co

nose

coug

injur

fetal deaths, decreased weight, changes and delay in the skeletal development. It is not however considered teratogenic (Calabrese and Kenyon 1991; ATSDR 1993).

Xylene is not classified as a carcinogen in the EPA weight-of-evidence classification. No associated cancer cases have been reported. The xylene isomers are not genotoxic, whether administred in combined form or individually. They are considered also non-teratogenic, although delayed development, decreased fetal weight, and altered enzyme activities were observed (Calabrese and Kenyon 1991).

7.5 Threshold

No no-observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) were proposed for reproductive toxicity due to benzene. However, NOAEL of 10 ppm for both maternal and fetal toxicity in rats has been suggested (Calabrese and Kenyon 1991; ATSDR 1992).

At concentrations between 0.1 and 3 ppm of formaldehyde, irritation of the eyes, skin, nose and throat are observed. Slightly higher concentrations, around 5 ppm, result in coughing and chest tightness (asthmatic's problem). More than 50 ppm can cause severe injury, and lead to pneumonia and pulmonary edema (Calabrese and Kenyon 1991).

E

P

(C

B

(1

Ba

(o

K

7.

It i

co

un

co

ca

cha

tar

co

poi

Based on systemic toxicity, OSHA has established a threshold limit value (TLV) for phenol of 0.024 ppm (0.009 mg/m^3) for an 8-hour time-weighted average (TWA) (Calabrese and Kenyon 1991; ATSDR 1992).

Based on systemic toxicity, the ACGIH has established a TLV for toluene of 0.38 ppm (1.4 mg/m^3) based on an 8-hour TWA (Calabrese and Kenyon 1991; ATSDR 1993).

Based on systemic toxicity, the ACGIH has established a TLV for the combined isomers (o-, m-, p-) for xylene of 1.2 ppm (5.2 mg/m^3) based on an 8-hour TWA (Calabrese and Kenyon 1991; ATSDR 1992).

7.6 Exposure to Multiple Compounds

It is apparent that toxicity testing under realistic environmental conditions is a much more complex enterprise than determining the effects of a unique chemical on a unique specie under controlled laboratory settings. The insult to the total organism from multiple compounds is difficult to assess. For example from a toxicological point of view, all carcinogens do not cause the same form of cancer. Thus, the burden from different chemicals should not be combined linearly without specific information that the same target organ is affected. None-the-less, one would expect that exposure to multiple compounds is a greater burden than to one compound and that, potentially, from a holistic point of view, the total impact is greater than the sum of the individual impacts.

R

A1

A1

Ca

Hay

U.S

We

References

ATSDR (1992). Case Studies in Environmental Medecine, U.S.Department of Health and Human Services.

ATSDR (1993). Case Studies in Environmental Medecine, U.S.Department of Health and Human Services.

Calabrese, E. J. and E. M. Kenyon (1991). Air Toxics and Risk Assessment. Chelsea, Lewis Publishers, Inc.

Hayes, A. W. (1994). Principles and Methods of Toxicology. New York, Raven Press.

U.S.EPA (1994). Instant EPA's Air Toxics. Austin, Texas, Instant Sources, Inc and Digital Liaisons.

Wexler, P. (1995). TOXNET: An Online Resource for environmental and Toxicological Inforrmation.

Chapter 8

Risk Characterization

Risk characterization is a summary of the information gathered during the exposure and toxicity assessment to present qualitative and quantitative conclusions about the risk. The risk characterization should contain not only a risk estimate for a given exposure scenario but also a summary of the relevant biological information, the assumptions used and their limitations, and a discussion of uncertainties in the risk assessment (Paustenbach 1989).

8.1 Point Estimation of Cancerous and Non-cancerous Risk

For low-dose cancer risk (smaller than 0.01), the quantitative risk for a single compound by a single route is calculated as (Hertz and Thomas 1983; U.S.EPA 1991):

$$\text{Risk} = \text{Intake} \times \text{Slope Factor} \tag{8.1}$$

Where

Intake = LADD calculated in the exposure assessment.

Slope factor = characteristic of the contaminant obtained from Integrated Risk Information System, IRIS.

For higher carcinogenic risk levels (greater than 0.01), the following equation is used:

$$\text{Risk} = 1 - \exp[-\text{Intake} \times \text{Slope Factor}] \quad (8.2)$$

To describe potential non-carcinogenic effects occurring in individuals due to hazardous air pollutants, a noncancerous hazard quotient or hazard index (HI) is used instead of the risk expression. The EPA recommends the use of the following equation (Hertz and Thomas 1983; U.S.EPA 1991):

$$HI = \frac{\text{Intake}}{RfD} \quad (8.3)$$

where

RfD = Reference Dose, mg/kg·day
(RfC is used for inhalation)

Risk interpretations from the hazard index are quite different from those of the cancer risk. While the latter is interpreted as a statistical probability, the former is a reference of the level of concern. The greater the value above the unity, the greater the concern.

8.2 Probabilistic Risk Evaluation

As it is shown in Equations 8.1 and 8.2, the cancer risk value is derived from the product of two parameters. In the point estimate approach, a single value is assumed for each of them. For example the slope factor is the 95% upper confidence limit of the slope calculated from the dose response curve. Only a single, unique value (as opposed to a

PI

in

A

as

wa

fac

sing

risk

path

8.3

In ter

appro

the o

proce

imple

even t

on the

Forma

causes

PDF) is available due to the lack of information (slope factor literature review is available in chapter 7).

A variety of intake values associated with different pathways and population ages as well as exposure duration were explored in the present research. A PDF for the "Intake" value was developed and, because there was no alternative, a point estimate of the "slope factor," "RfC" or "RfD," depending upon the compound, was used. Hence, rather than a single value of the risk corresponding to a certain exposure to the chemical, a range of risk values is given that describes the risk to the associated population with the specified pathway and route of exposure.

8.3 Total Integrated Risk

In terms of risk evaluation, a value integrated over multiple chemicals is not always appropriate. One can not simply add the risk values of individual chemicals to calculate the overall risk. With the new risk assessment guidelines and the weight of evidence procedure (U.S.EPA 1997), a new approach to carcinogenic risk characterization is being implemented. This includes the idea that all chemicals act in the same fashion. Thus even though several chemicals may be shown to induce cancer, they don't necessarily act on the same organ. For example, benzene and formaldehyde are both carcinogenic. Formaldehyde induces nasal cancer (Andjelkovitch, Janszen et al. 1995), while benzene causes leukemia (Hayes 1994). Thus, their residual cancer risk is not cumulative.

I

I

e

e

sc

ar

Th

ho

for

the

per

this

8.4

Anot

uncer

On the other hand, considering the foundry as the only source in the risk evaluation without investigating possible other sources that might contribute to the atmospheric concentration at the ground level or in the indoor environment might lead to an underestimation of the hazard of some of these chemicals. It has been reported, for example, that homes, especially mobile homes, release pollutants such as formaldehyde into the indoor air. Formaldehyde is an indoor air pollutant of particular concern for houses with low indoor air exchange and urea-formaldehyde foam insulation (Stock 1987). Because individuals are inside their homes 60-75 percent of the time (Sexton, Liu et al. 1986), in-home concentrations are often the single best determinant of individual exposure. Concentrations of formaldehyde in indoor air ranged from 0.05 to 0.18 ppm in some studies (Sexton, Liu et al. 1986; Stock 1987). Thus, cumulative risk from indoor and outdoor formaldehyde exposure must be considered in future risk assessment.

The same situation holds for benzene. Exposure from smoking, consumer products in the home, and personal activities such as driving or painting have been estimated to account for more than 80% of the nationwide exposure to benzene (Lioy 1990 304). It is, therefore, very important to recognize the potential contributions from other sources and perform exposure assessment for air pollutants within a frame that takes consideration of this issue.

8.4 Uncertainty Analysis

Another key component of the risk characterization is the discussion and analysis of the uncertainty. There are a variety of ways of expressing uncertainty. In the classic point est

mi

198

ma

~0.

mg

The

beca

mea

8.5

Risk

the c

for b

here.

three

targe

resul

scena

8.3 re

partic

estimate approach in describing the dose, a phrase such as "it is plausible that someone might absorb as much as 5 mg/kg·d" might be used to exposure uncertainty (Paustenbach 1989). A more rigorous analysis provides a distribution of exposure assessment. This may be expressed as a PDF, a CDF or a verbal description of the distribution such as "0.5% of the population might absorb as much as 5 mg/kg·d, 70% might absorb 0.5 mg/kg·d and 29.5% is likely to absorb less than 0.1 mg/kg·d" (Paustenbach 1989).

The probabilistic risk assessment used in this research explicitly includes uncertainty because the final output is presented as a PDF. Thus, risk values incorporate both a measure of uncertainty and results from uncertainty in the input parameters.

8.5 Results And Discussion

Risk values for the five identified chemicals were determined for different times during the day from 7:00AM to 11:00PM, and at different receptors (R1, R2, and R3). Results for both the case study resin binder, and the selected comparison binders are summarized here. The assessment for only the carcinogen benzene, and the noncarcinogen phenol for three particular scenarios for men are presented (see Table 8.1 and Table 8.2). Different target populations: children, women, and men were also examined and the assessment results are shown in Table 8.3. Detailed risk and HI results for all chemicals, different scenarios, and binders are available in Appendix J. The numbers in tables 8.1, 8.2 and 8.3 represent the mean values corresponding to distribution functions of the risk for the particular scenarios.

Table 8.1 Cancer Risk Estimates (in Unit Risk) from Benzene Inhalation for Men at Receptor R3 Based on Shift Start Time

Risk Estimates for 1991	Emission Factor Lb/ton iron	**7AM**	**3PM**	**11PM**
Case Study Resin Binder	0.084100	1.11E-05	1.02E-05	1.43E-05
Phenolic 'NoBake	*0.672540*	8.90E-05	8.12E-05	1.14E-04
Phenolic 'Urethane	*0.321060*	4.25E-05	3.88E-05	5.45E-05
Phenolic ' HotBox	0.060120	7.96E-06	7.26E-06	1.02E-05
Green 'Sand	*0.036660*	4.85E-06	4.43E-06	6.23E-06
Core Oil	*0.140640*	1.86E-05	1.70E-05	2.39E-05
Shell	0.400020	5.29E-05	4.83E-05	6.79E-05
Nitrogen Furan	0.038880	5.15E-06	4.70E-06	6.60E-06
Nitrogen 'Furan-TSA	0.272040	3.60E-05	3.29E-05	4.62E-05
Furan ' HotBox	0.032220	4.26E-06	3.89E-06	5.47E-06
Alkyd 'Isocyanate	*0.320160*	4.24E-05	3.87E-05	5.44E-05
Silicate-'-Ester	*0.084600*	1.12E-05	1.02E-05	1.44E-05

Table 8.2 HI Estimates (unitless) from Phenol inhalation at Receptor R3 Based on Shift Start-Time

Risk Estimates for 1991	**EMISSION FACTOR Lb/ton iron**	**7AM**	**3PM**	**11PM**
Case Study Resin Binder	0.581400	4.41E-03	4.03E-03	5.66E-03
Phenolic 'NoBake	*0.058500*	4.44E-04	4.05E-04	5.70E-04
Phenolic 'Urethane	*0.234240*	1.78E-03	1.62E-03	2.28E-03
Phenolic ' HotBox	0.234240	1.78E-03	1.62E-03	2.28E-03
Green 'Sand	*0.007860*	5.97E-05	5.45E-05	7.66E-05
Core Oil	*0.003420*	2.60E-05	2.37E-05	3.33E-05
Shell	0.147360	1.12E-03	1.02E-03	1.44E-03
Nitrogen Furan	0.001440	1.09E-05	9.98E-06	1.40E-05
Nitrogen 'Furan-TSA	0.006060	4.60E-05	4.20E-05	5.90E-05
Furan ' HotBox	0.000960	7.29E-06	6.65E-06	9.35E-06
Alkyd 'Isocyanate	*0.000110*	8.35E-07	7.62E-07	1.07E-06
Silicate-'-Ester	*0.016380*	1.24E-04	1.13E-04	1.60E-04

Table 8.3 Comparison of Cancer Risk Estimates (in Unit Risk) from Benzene inhalation at Receptor R3 for Women, Children, and Men

Scenarios		7AM	3PM	11PM
Children	Year 1991	1.11E-05	1.02E-05	1.43E-05
	Overall Risk 1987-1991	1.14E-05	9.89E-06	1.20E-05
Women	Year 1991	8.15E-05	7.44E-05	1.05E-04
	Overall Risk 1987-1991	8.33E-05	7.24E-05	8.81E-05
Men	Year 1991	6.78E-05	6.18E-05	8.69E-05
	Overall Risk 1987-1991	6.92E-05	6.02E-05	7.32E-05

These distributions are all lognormal as shown in the example of Figure 8.1 As it can be seen from these numbers, the case study resin produces a risk similar to the one produced by *Silicate-'-Ester*. Results from other binders show a potential risk reduction up to 60% by using an alternate binder such as *Furan ' HotBox* instead of the current binder. This is based, of course, on the potential emissions. Other factors have to be considered to determine if such an alternative is feasible. While all risk values are in the range of acceptable risk 10^{-6} to 10^{-4}, it is important to note that only the residual risk from exposure to a single chemical, in a single medium, and through a single route was considered in this study. Thus, cumulative effects from other sources, and other chemicals can lead to increased cancer risk values that could exceed the acceptable value.

Risk values for different populations did not show major variability. Children's risk was lower due to the shorter exposure time in comparison to the adult exposure time. A slight difference was also observed between women and men and that was due to the difference in body weight.

The Figure 8.1 illustrates the risk distribution function for benzene averaged over the five years of meteorological data for production that started at 7:00AM. The risk distribution was fitted to a log-normal distribution that was characterized by a mean of 7 E-05 and a 95% value of 2.5 E-04. For comparison purposes, the EPA point estimate risk value was

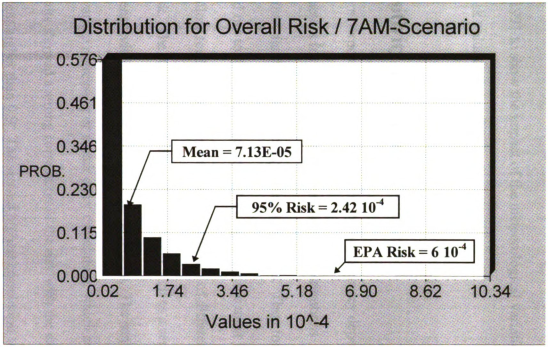


Figure 8.1 Risk Distribution for Benzene Inhalation

calc

twic

(52

Cur

year

to a

8.6

As

cho

dis

an

va

fu

m

u

T

E

i

I

a

i

calculated. It was about 6 E-04 as shown in Equation (8.4). This value was more than twice as big as the 95th percentile of the risk resulteing from the probabilistic approach.

$$\frac{(5.27 \mu g/m^3)\cdot(20 m^3/hr)\cdot(365 days/yr)\cdot(40 yr)\cdot(24 hrs/day)}{(70 kg)\cdot(70 yrs)\cdot(365 days/yr)}\cdot(2.9 10^{-5}(\mu g/kg.day)^{-1}) = 5.99 10^{-4} \quad (8.4)$$

Cumulative distribution functions are also plotted separately on the same graph for each year from 1987 to 1991 to show the impact of the meteorological variation from one year to another on the risk values (Figure 8.2).

8.6 Risk Sensitivity To Exposure Factors

As mentioned before, exposure assessment efficiency and accuracy depend largely on the choice of the key factors involved and their representative distributions. Selecting one distribution rather than another will probably affect the results. Therefore, a sensitivity analysis was carried out to determine the key factors that have the most impact on the risk values. This will allow for future exploration of the influence of different distribution functions on the risk. The tornado graph shown in Figure 8.3 gives a sense of the magnitude of the sensitivity of the risk to each of these factors. The sensitivity analysis uses either a multivariate regression or a rank order correlation, which are both linear. The sensitivity results showed a strong correlation of the risk with the exposure duration, ED, with a coefficient higher than 0.9. The second highest correlation is with the inhalation rate, IR, third is the exposure time, ET, and the fourth is the body weight, BW. This ranking suggests the parameters that should be focused on in future investigations, and for which more elaborate sensitivity analysis should be performed to study their impact on the risk evaluation.

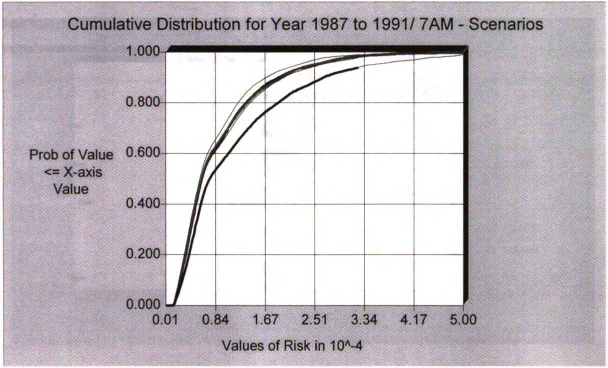


Figure 8.2 Cumulative Risk for Benzene from 1987 to 1991

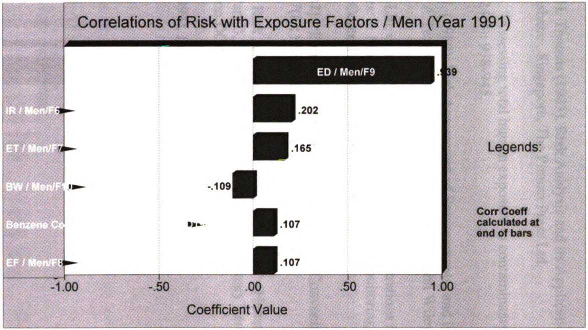


Figure 8.3 Sensitivity Analysis Risk-Exposure Factors

R

An

Ha

He

Lic

Pa

Sey

Sto

U.S

U.S

References

Andjelkovitch, D. A., D. B. Janszen, et al. (1995). "Formaldehyde Exposure Not Associated with Cancer of the Respiratory Tract in Iron Foundry Workers." Chemical Industry Institute of Toxicology (CIIT) 15(7): 1-9.

Hayes, A. W. (1994). Principles and Methods of Toxicology. New York, Raven Press.

Hertz, D. B. and H. Thomas (1983). Risk Analysis and its Applications. Chichester . New York . Brisbane . Singapore, The Pitman Press Ltd.

Lioy, P. J. (1990). "Assessing total human exposure to contaminants." Environ. Sci. Technol. 24(7): 938-945.

Paustenbach, D. J. (1989). Risk Assessment of Environmental and Human Health Hazards: A Textbook of Case Studies. Alameda, John Wiley & Sons.

Sexton, K., K. S. Liu, et al. (1986). "Formaldehyde Concentrations Inside Private Residences: A Mail-Out Approach to Indoor Air Monitoring." Journal of the Air Pollution Control Association 36(6): 699-704.

Stock, T. H. (1987). "Formaldehyde Concentrations Inside Conventional Housing." JAPCA 37(8): 913-918.

U.S.EPA (1991). Risk Assessment Guidance for Superfund - Human Health Evaluation Manual(Part B, Development of Risk-based Preliminary Remediation Goals). Washington DC., EPA.

U.S.EPA, Ed. (1997). Integrated Risk Information System.

Chapter 9

Risk Assessment Techniques as a Tool for Selecting Pollution Prevention Alternatives

9.1 The Decision Making Process

A rational approach to decision making is based on an educated, documented, open judgment. Most importantly, the process of decision making must be explicit and communicable, objective and self-correcting, and verifiable and reproducible (Baird 1989).

The minimum critical steps in decision making are:

- Definition of the problem;
- Listing of options;
- Definition of criteria;
- Analysis of the options;
- Choice of course of action.

9.1.1 Difficulty in Decision Making

Some decisions cannot, of course, be reduced to simple deterministic algorithms. In some cases, the number of solution alternatives may be infinite, and consideration of all options is, hence, impossible. Also, multiple objectives to be achieved as an outcome to the process might be difficult to weigh, in particular the ones that are in direct conflict with others. Often, more than one decision maker is involved in the process and this raises the problem of group dynamics and interpersonal relationships. On the other hand, what is " best" for one individual, one organization, or one society is not necessarily best for others. Finally, a "good" judgment is still based on the information available to the decision maker and might not be the "correct" one based on the outcome of the decision. Therefore, any decision should remain open to verification and correction (Lindley 1985; Baird 1989).

9.2 Decision Making Under Uncertainty

A decision problem occurs whenever there is a choice between at least two courses of action. Having all the information regarding decision choices does not lead, necessarily, to making the right decision, because decisions are based on judgments (Lindley 1985). It is a precept of decision making that a more educated choice results when a good knowledge of the risk involved is available.

The natural reaction of decision makers to uncertainty is to acquire more information to minimize as much as possible these uncertainties. The problem, however, is how much it costs to obtain the information and how useful this knowledge will be in reducing the uncertainty.

One of the most valuable benefits of the probabilistic risk approach is the broad range of choices that this method can give to the decision maker. With a better description of the risk and the different factors that impact on its value, it is possible to consider different options instead of merely a "yes" or "no" to a particular scenario. A risk PDF allows not only an assessment of the range of importance but also provides a symbolic measure of the risk.

An essential goal in decision making is to choose an action that can be carried out. It is rather useless to select an option that can not be realized. Hence, feasibility is an essential factor to consider in decision making. Feasibilty may reflect the availability of monetary or technical resources or the chance of public acceptance.

9.3 Application of Risk Assessment to the Selection of a Resin Binder

The following discussion outlines the "critical steps in decision making" for applying risk assessment to the selection of a binder that minimizes atmospheric pollution from VOCs.

9.3.1 Definition of the Problem

As one may note from the investigations reported in previous chapters, alternative means of reducing the risk from the air emissions from the casting process have been examined. Some of these options, such as schedule alternation and stack height alteration, do not prevent pollution but only redistribute the pollutants so that the risk is reduced. For the selection of pollution prevention alternatives the "problem definition" must be narrowed.

The simple statement of the problem is: "how can the foundry prevent pollution of the air by emissions from the casting process?" For the purpose of this research, the problem is bounded, that is to say: "of the pollution prevention alternatives, based on risk, which is the most desirable?" The problem is further bounded, from an outsiders point of view, in that the alternatives for pollution prevention are restricted to the selection of resins from those commercially available. Reformulations or new formulations, innovative casting techniques, new metals (such as aluminum), etc. are beyond the purview of this work.

9.3.2 Listing of Options

Under the bounded problem definition, the options for pollution prevention are limited to the 19 binder formulations commercially available. Of these, the risks of only eleven could be analyzed because of the availability of data. These alternative resins and their estimated emissions are listed in Table 9.1.

9.3.3 Definition of Criteria

Although the criteria for selection of a resin include such things as the type and size of the cast, the characteristics of the sand, and the cost, the bounded problem for this research limits the criteria to selection of the resin that minimizes the total inhalation risk.

Table 9.1 List of Resin Binders Ranked Based on Their Total Yearly Emissions of the Selected HAPs

Type Mold/ Core-Binder	0. Case Study	1. Phenolic NoBake	2. Phenolic Urethane	3. Phenolic HotBox	4. Green Sand	5. Core Oil	6. Shell	7. Low Nitrogen Furan	8. Med. Nitrogen Furan-TSA	9. Furan HotBox	10. Alkyd Isocyanate	11. Sodium Silicate--Ester
INDEX		Resin	Resin	Resin	Seacoal	Core Oil	Resin	Resin	TSA Ctlyst.	Resin	Resin+Isocy.	Sugar+Ester
HAPs	HAPs Emission Factors Wt./ Wt.(ie. lb-Contaminant/ lb-INDEX											
Benzene	1.402E-3	1.121E-2	5.351E-3	1.002E-3	6.110E-4	2.344E-3	6.667E-3	6.480E-4	4.534E-3	5.370E-4	5.336E-3	1.410E-3
Formaldehyde	1.860E-3	1.000E-5	2.200E-5	6.000E-6	4.000E-6	9.600E-5	3.500E-5	2.670E-4	6.500E-5	9.000E-6	1.060E-4	1.690E-4
M-Xylene	1.733E-4	9.700E-5	4.390E-4	1.210E-4	2.100E-5	2.390E-4	5.850E-4	2.227E-3	2.430E-4	3.200E-5	2.522E-3	9.400E-5
O-Xylene	1.733E-4	4.900E-5	1.320E-4	3.000E-5	2.100E-5	2.870E-4	1.170E-4	7.290E-4	4.000E-5	3.200E-5	3.838E-3	9.400E-5
Phenol	9.690E-3	9.750E-4	3.904E-3	2.030E-4	1.310E-4	5.700E-5	2.456E-3	2.400E-5	1.010E-4	1.600E-5	1.100E-4	2.730E-4
Toluene	5.667E-4	6.340E-4	8.330E-4	1.820E-4	6.300E-5	4.780E-4	2.807E-3	1.210E-4	8.826E-3	3.200E-5	1.535E-3	2.820E-4
*Total HAPs-->	1.387E-2	1.297E-2	1.068E-2	1.544E-3	8.510E-4	3.501E-3	1.267E-2	4.016E-3	1.381E-2	6.580E-4	1.345E-2	2.322E-3
@Max.-HAP->	9.690E-3	1.121E-2	5.351E-3	1.002E-3	6.110E-4	2.344E-3	6.667E-3	2.227E-3	8.826E-3	5.370E-4	5.336E-3	1.410E-3
@Max.(H)=8760 Hrs/ Yr	1.5%	1.5%	1.0%	2.0%	*--1.5%	1.0%	3.0%	???	1.5%	2.0%	1.3%	1.5%
%INDEX by Wt./ SAND	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
RATIO SAND/ Metal	3/1	3/1	3/1	3/1	3/1	3/1	3/1	3/1	3/1	3/1	3/1	3/1
Melt Capacity= Ton/ Hr---:	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PTE@Max.(H)hrs--Ton/ Y	8,760	8,760	8,760	8,760	8,760	8,760	8,760	8,760	8,760	8,760	8,760	8,760
lb--INDEX/ Yr	525,600	525,600	525,600	525,600	525,600	525,600	525,600	525,600	525,600	525,600	525,600	525,600
Tons--TOTAL-HAPs/ Yr-->	3.64	3.41	2.81	0.41	0.22	0.92	3.33	1.06	3.63	0.17	3.53	0.61
Tons--MAX-HAPs/ Yr-->	2.55	2.95	1.41	0.26	0.16	0.62	1.75	0.59	2.32	0.14	1.40	0.37
Ranking based on Total Emission	LAST	9	7	3	2	5	8	6	11	1	10	4

Even with this great simplification, selecting the best alternative is not easy to resolve because the "total inhalation risk" is difficult, if not impossible, to define based on fundamental scientific principles. For example, as discussed in Chapter 8, because different compounds have different target organs, combinations of quantitative estimates of risk are not scientifically defensible. On the other hand, risk managers must make decisions based on the information available and independent risk calculations may result in a "no effect" decision that is highly erroneous as well as one that is unacceptable to the public.

For the purpose of this research, four alternative decision criteria were considered:

- Lowest emission
  The lowest emission criteria is to simply select the binder resin with lowest total estimated mass emission;

- Comparison with acceptable cancer risk value or hazard index
  In this alternative those compounds whose risk or hazard index is above some threshold risk or hazard criteria are screened out. For example all resins with no compounds exceeding a cancer risk of 10^{-4} and a HI of 1.0 would be deemed acceptable;

- Total risk
  This will be calculated using the protocol for combining risk and hazard indexes published by the EPA (U.S.EPA 1989) with the exception that the mean values of risk are utilized rather than the risk corresponding to the reasonable maximum exposure (RME) scenario.

- Relative marginal increase in risk
  In effect, a risk calculation based on single source is an estimate of the marginal increase in risk. Since this estimate is out of context of the total exposure an individual may experience, the relative impact of the risk is not assessed. A relative risk assessment requires an estimate using the total exposure assessment methodology, TEAM, proposed by the EPA in a multimedia, multiple pathway, multiple routes model. The risk from an individual compound is compared to the total risk and then minimized over all compounds by selection of the appropriate resin.

It is self-evident that a number of other decision criteria may exist. A cursory review of texts on management decision theory (Baird 1989) revealed a number of techniques that appear appropriate for making risk management decisions. Because of the scope of this work and the vast potential scope of an exploration of management decision theory, it is left for future research.

The lowest emission criterion is the easiest to use but it may not result in the lowest risk because risk is not considered.

The comparison approach assumes that risks below a threshold do not contribute to the body burden. However, given the uncertainty of toxicological assessments, this may appear to be acceptable management decision criterion. In addition, it has the potential advantage of leaving several alternatives to which other selection criteria may be applied t

t

n

o

9

Fo

m

Po

ris

so

Pe

as well as not violating the toxicological "rule" that contraindicates combining risks. However, it may not be perceived as acceptable by the public.

The EPA combined risk technique has the decided advantage of providing the decision maker with two lumped parameters: risk and HI. The disadvantages of the technique are that it violates the toxicological "rule" and the selection of mean (or the RME for that matter) discards most of the information gained from using a probabilistic approach.

While the relative marginal risk approach appears to provide a method for assessing all the components of risk without violating the toxicological "rule," it does, in fact, measure the marginal elements to be combined in some fashion. Furthermore, its implementation requires either an extensive environmental audit or a large number of assumptions about other exposures.

9.3.4 Analysis of the Options

For the purpose of comparison, the selection of a resin (or resins) to prevent pollution was made based on each of the first three criteria discussed in 9.3.3.

Possible actions must now be carefully studied in terms of the desired outcomes, after risk evaluation and comparison of the different results. Also reliability of the information source should be assessed objectively. Analysis of the solution trade-offs can then be performed.

9.3.4.1 Lowest Emission

A mass balance analysis of emission rates allowed the identification of the resin with lowest emissions per year. Computations were performed using emission factors of the toxic chemicals compiled by Mosher. A ranking of the different resins available on the market could then be made and used to select of the system binder with lowest emissions. Based on the results of mass balance shown in Table 9.1, the Furan Hotbox resin presented an alternative considering its low yearly emissions of the selected chemicals lumped together and for the HAP of concern (benzene) as well.

9.3.4.2 Comparison with Acceptable Risk Values

Using the risk techniques presented in the previous chapters, one can eliminate some of the system binders which exhibit higher levels of risk compared to the system in use in the case study. As can be seen in Table 8.1, the risk values for some of the binders explored in this research were higher than the case study. For example phenolic no bake, phenolic urethane could be eliminated at the screening level to allow more time and effort to be dedicated to the ones that present a potential reduction of the actual emissions.

Another way of performing the screening is to use an acceptable risk value beyond which the binder should be rejected. In this case, an E-06 was chosen as a safe level of risk to accept. All resin binders that generated a higher risk should be eliminated. Seven of the binders investigated for benzene emissions will then not be considered. These are:

phenolic no bake, phenolic urethane, core oil, shell, nitrogen furan TSA, alkyl isocyanate, and silicate ester. Furan hot box is again a potential selection from the rest of binders.

9.3.4.3 EPA Combined Cancer Risk and HI

One can also use the EPA approach to lump the risk from all chemicals to sum their impacts on human health. Combined risk from simultaneous exposure to carcinogenic compounds, benzene, and formaldehyde is presented in Table 9.2.

Table 9.2 Combined Risk from Exposure to Multiple Chemicals

Resin Binders	Benzene	Formaldehyde	Total Risk
Case Study	**8.38E-06**	**1.11E-05**	**2.13E-05**
Phenolic 'NoBake	6.71E-05	5.98E-08	6.71E-05
Phenolic 'Urethane	3.20E-05	1.32E-07	3.21E-05
Phenolic ' HotBox	5.99E-06	3.59E-08	5.02E-06
Green 'Sand	3.65E-06	2.39E-08	3.67E-06
Core Oil	1.40E-05	5.74E-07	1.46E-05
Shell	3.98E-05	2.09E-07	4.00E-05
Nitrogen Furan	3.88E-06	1.6E-06	5.48E-05
Nitrogen 'Furan-TSA	2.71E-05	3.89E-07	2.75E-05
Furan ' HotBox	3.21E-06	5.38E-08	**3.26E-06**
Alkyd 'Isocyanate	3.19E-05	6.34E-07	3.25E-05
Silicate-'-Ester	8.43E-06	1.01E-06	9.44E-06

Based on the total risk, FuranHotbox is again a potential for risk reduction. It is also clear that this binder is not the only alternative for investigation. Phenolic Hotbox and green sand should be considered as well.

9.3.5 Selection of Course of Action

Making the decision, which course should be taken, is yet the most critical exercise to enterprise. An immediate action to be made is to investigate the possible use of binders predicted to involve less risk based on their emission factors. A closer look to their chemical composition is to be made to determine if they satisfy the casting requirement as a comparison with the one in use right now. This, of course, will eliminate the additional cost that could be generated in taking a different course such as change in stack heights, or implementation of better control systems.

Favoring solutions that will reduce the risks at the source, the course of action of choice will be to reduce the emissions by optimizing the use of binders. Furan hotbox is, a priori, the best alternative to the current resin. But, this will remain open to verification of its chemical composition and whether, it meets quality requirements of the cast.

As it can be seen from the previous exercise, different choices are possible. A unique course of action is, however, not necessarily the right choice. A combination of two or more alternatives may be a more appropriate way of solving the problem. In this case, a decision only based on a simple estimate of risk is not going to be sufficient to prevent pollution, since this risk value is not integrative of all the chemicals, all the sources, all the media, and the routes of exposure. Also, in addition to risk reduction total emissions per year should be also reduced.

References

Baird, B. F. (1989). Managerial Decisions Under Uncertainty An Introduction to the Analysis of Decision Making. Toronto, CAN, John Willey & Sons, Inc.

Lindley, D. V. (1985). Making Decisions. London . New York . Toronto . Singapore.

U.S.EPA (1989). Risk Assessment Guidance for Superfund - Human Health Evaluation Manual. Washington DC., EPA.

Chapter 10

Summary, Conclusions, and Recommendations

10.1 Summary of Research Work Completed

In May 1995, a literature review was initiated. About 300 references were abstracted and investigated. For a better understanding of the different processes involved in the foundry industry two field trips were made: one to the selected GM foundry in Saginaw; and one to the Ford Motor Company plant in Windsor, Canada. As a result of the literature search and these site visits, an initial scope for the study was selected. Casting (pouring, cooling, and shakeout) was identified as the primary generator of Hazardous Air Pollutants. These investigations also suggested a preliminary list of target compounds of concern: benzene, formaldehyde, phenol, toluene, and xylene.

Emission calculations were initiated using a computer code provided by Mr. Oviatt from the Michigan Department of Environmental Quality, MDEQ. Calculations were made for casting emissions based on emission factors provided by Mosher (Mosher 1994).

An attempt was made to reproduce one of the emission factors obtained by Mosher through a mass balance process. A mass balance model for the casting steps was built to account for mass rates in and out of the control volume including losses and gains by chemical reactions. Reasonable stack concentrations for a selected pollutant were obtained.

For predicting the ambient impact of these pollutants, the selection of a suitable dispersion model was based on the application and the available data. The Industrial Source Complex, ISC-3, was selected to perform atmospheric dispersion of the prioritized list of HAPs and predict their fate at the receptors of interest.

Source and meteorological data were gathered and utilized to generate atmospheric concentrations of the contaminants. Transport of these chemicals was investigated far from the source and an area of two kilometers was selected for exposure assessment and intake evaluation.

A risk assessment was conducted using probability distributions for the exposure factors used in health risk assessment. Computer simulations were used to facilitate statistical risk analysis.

10.2 Conclusions

An essential goal of this study was to use risk assessment to help develop risk management decisions that are more systematic, more comprehensive and accountable than before. Hypothetical cases and "what if" scenarios can be investigated via risk assessment models to evaluate the impact on human health of pollution prevention. In particular, the risk assessment technique can be used as a tool to assess pollution prevention alternatives. One of the important findings of this research was the influence of the variability of the ISC3 source term on the exposure estimates. From the risk values, it is obvious that several binders are likely to emit much less HAPs than the current one in use, and as a consequence a potential reduction of the risk is available by changing binders. Finally, a major conclusion of this research is that the classic point risk method overestimates the risk for the general population exposed.

10.3 Recommendations for Reducing Risk

The recommendations are divided into two categories: those that reduce risk and those that reduce risk by pollution prevention. Based on the evaluated risk, analysis of potential reduction at the source or through use of alternate control systems have been investigated. Some of the corrective measures that could substantially minimize the risk are:

- Changing the heights of stacks in different lines and increasing the hight of the one that has the most impact on exposure levels to improve their dispersion;
- Optimizing of the scenario (combination) of operating lines during the day to give the lowest concentration at the ground level. For example, since the 3PM scenario seems to give the lowest concentrations; it may be appropriate to run the line that produces most of the emissions at that time. The other lines could be run at a different times since their emissions are lower;
- Finally, alternate control systems should be implemented to achieve lower emissions.

Based on the production rates of the facility under study, it is recommended that the lines with higher rates be scheduled at the favorable times (3 - 4 PM start) and the lines with lower production rates be run during the morning shift. This will allow reduction of the ground level concentrations at this critical time when the atmospheric conditions are not favorable.

10.4 Recommendations for Future Work

In future work, concentrations of the different chemicals in the binder and the sand before and after pouring should be explored. This will minimize the uncertainties due to multiple assumptions in makeup ratios and the concentrations in the remaining sand. Another problem faced in the mass balance process is that most HAPs are generated from reactions of the binder chemicals. For instance, the highest emission rate is for benzene; however, it does not appear in the initial binder component list. Investigation of the chemical reactions and the pathways that generate the HAPs is an obvious next step. Other work that should be conducted includes:

- **Monitoring** of the emission rates at the stacks for a more accurate distribution function of the concentrations at the receptors;

- **Study of the Reactions** of the toxic chemicals of concern to more accurately determine their fate at the receptors;

- **Mass balance** model calibration for more accurate analysis of the emissions before their capture; and

- **Investigating Resins** with lower emissions than the one in current use.

10.5 Future Research

The scope of this research was, largely, dictated by the available data, the financial resources, and the time constraints. It does, however provide the basis for more elaborate research that promises to greatly improve the risk assessment. As was hypothesized, previously, the intent in this study was to demonstrate that risk assessment techniques can be used to develop a strategy for pollution prevention. Some alternatives were explored as solutions to pollution reduction. Some of the recommended research efforts to be continued are:

- Pollution Prevention based on cost and risk
  Cost-risk-benefit analysis to define acceptable risks and industry willingness to pay for their reduction. This will depend essentially on financial resources, expectations, and time;

- Development of more realistic ED, EF, and ET PDFs
  To achieve acceptance of the probabilistic exposure model, standardized PDFs need to be identified. More efforts need to be deployed to develop reliable and representative probability distribution functions for the key exposure factors;

- Alternative metal (aluminum) for casting
  Investigate and compare the risks from the use of a different metal with lower melting temperature such as aluminum that could potentially reduce emissions;

- Design of a new resin to minimize major components of risk
  Since environmental have not been considered in developing the resin binders used in this industry, more research is required to understand the emissions evolving from their decomposition under the high temperature of the cast;

- Marginal risk minimization
  Investigation of the risk contribution from industry emissions to the total risk from all the sources. This will give a better idea about the risk in order to optimize the costs for it reduction;

- Explore population risk vs. point individual risk

- Apply management decision theory

- Develop a technique for graphical display of the risk modeling results.

References

Mosher, G. E. (1994). "Calculating Emission Factors for Pouring, Cooling and Shakeout." Modern Casting: 28-31.

Risk Assessment for Selecting Pollution Prevention Alternatives

By

Souad Benromdhane

Volume II

A Ph.D. Dissertation

Submitted to
Michigan State University
in partial fulfillment of the Requirements
for the Degree of

DOCTOR OF PHILOSOPHY

Department of Civil and Environmental Engineering

1998

APPENDICES

Appendix A

Appendix A
Sample Mass Balance Calculation

In support of the proposed mass balance approach to the sand operations of a foundry, a sample solution has been performed using data from the General Motors Powertrain Saginaw Malleable Iron Plant. Line 1, which produces gears, yokes and pistons, was chosen for analysis. Line 1 uses Sea Coal as the binder for the green sand molding process and both Hotbox and Coldbox processes are used in core production.

Many of the items required for a thorough mass balance of this line were not available. This resulted in a simplified mass balance that required several key assumptions. A detailed account, including a process flow diagram, of the mass balance and its assumptions is provided along with a graph that presents yearly HAP emissions with varied capture efficiencies.

The calculation used the following steps:

1. Use Coldbox cores of Line 1 only (neglecting the molds and Hotbox cores)

2. Coldbox process utilizes half of the core sand 0.5x7329 = 3665 lb/hr and half of the total metal charged (1/2)x(7 tons/charge) x (4 charges/hr.furnaces) = 56 tons/hr

3. Isocure cores use a two part resin binder:
   52% part I - 23.82 lb/hr
   48% part II - 23.75 lb/hr

4. Naphthalene was chosen as the organic within the binder the binder to follow for HAP emissions. A Material Safety Data Sheet was obtained for isocure, Part I and Part II, which revealed :
   Part I is 1-9% Naphthalene by weight ===> chose 9.0%
   Part II is 1-5% Naphthalene by weight ===> chose 5.0%

Therefore, the initial amount of naphthalene available should be:

23.82*(.09) = 2.14 lb/hr
23.75*(0.05) = 1.19 lb/hr

5. Pouring operation was selected for HAP emission analysis within the mass balance

6. Percent evaporation, percent reaction, and percent remaining in core information is only available for the stage where the sand is mixed with the binder. The following was obtained for naphthalene from a Form R reporting of foundry binder chemicals (AFS, 1995).

Part I (2.14 lb/hr)	Part II (1.19 lb/hr)
0% reacts	0% reacts
50% evaporates	50% evaporates
50% remains in core	50% remains in core

There, the amount of naphthalene entering the pouring operation is what remains in the core. For the two parts:

2.14(.5) + 1.19(.5) = 1.67 lb/hr

7. In determining how much of this remaining naphthalene will enter the air as a HAP during pouring, the worst case is to assume 100% volatilization. However, it was assumed that the Universal Treatment Standard amount of naphthalene remained in the sand for disposal.

Universal Treatment Standard	=	(5.6 x10-6 lb naphthalene/lb sand) (3665 lb Sand/hr)
	=	0.021 lb naphthalene/hr

There , 1.67 - 0.021 = 1.65 lb/hr of naphthalene is assumed to volatilize during pouring.

8. This 1.65 lb/hr is to be captured by a hood with a variable capture efficiency, µ, with an air flow rate of Q = 25,000 ft3/min.

9. The amount captured, 1.65*µ, is assumed to be controlled with a variable control efficiency, ß.

10. The amount of naphthalene emitted from the stack as a HAP from the pouring operation is then Mout*µ*(1-ß) lb/ft3 air.

11. The foundry operates 16 hours a day, 5 days a week, and 260 days a year

POURING PROCESS

All values are on an hour basis

Sand: Sin = Sout = 3665 lbs

Nap = Naphthalene

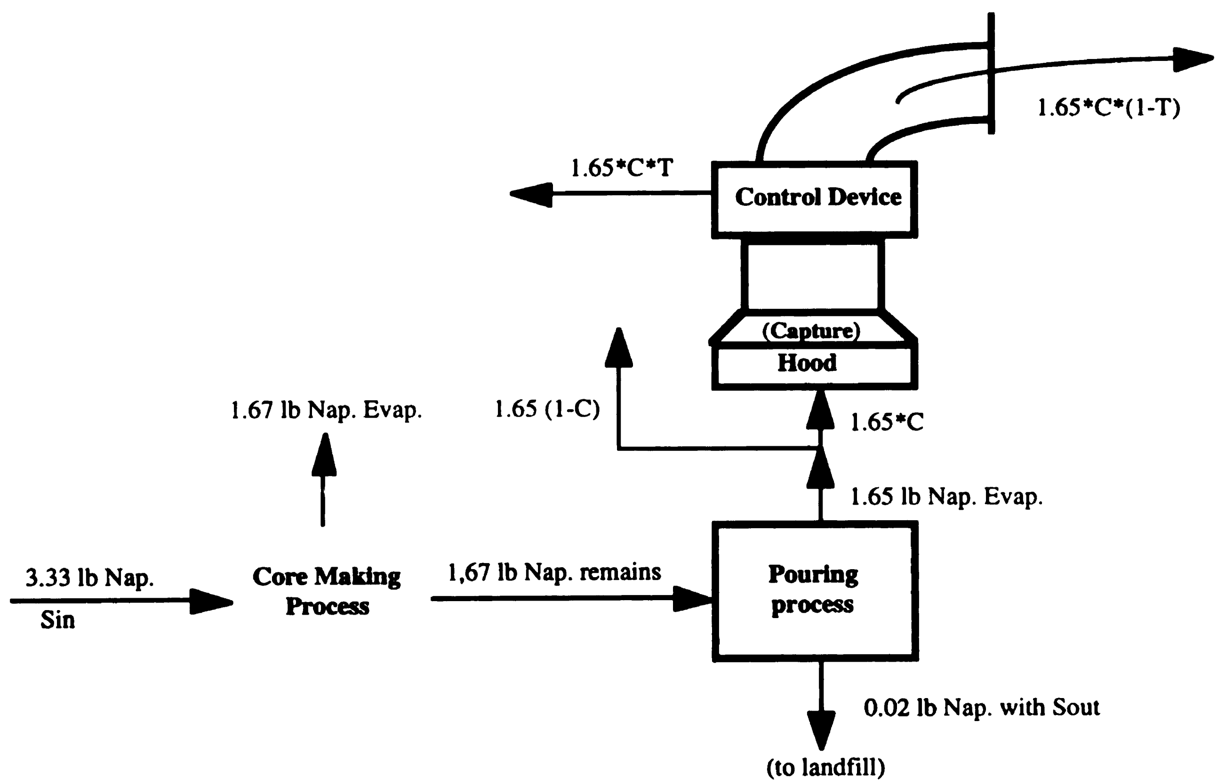
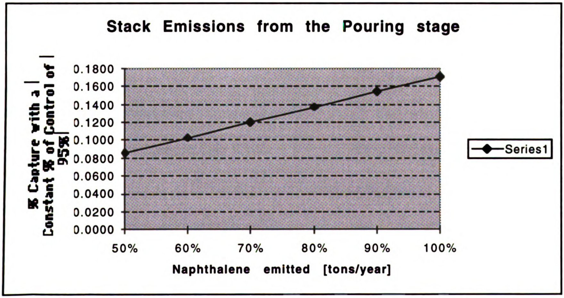


Table 1 Effect of Varied Capture Efficiency on yearly Emissions

HAP	Emission During Pouring (lb/hr)	Capture Efficiency C %	Control Efficienccy T %	Foundry Operation Schedule (hrs/year)	Stack Emission of HAP (tons/yr)
Naphthalene	1.65	50%	95%	4160	0.0858
	1.65	60%	95%	4160	0.1030
	1.65	70%	95%	4160	0.1201
	1.65	80%	95%	4160	0.1373
	1.65	90%	95%	4160	0.1544
	1.65	100%	95%	4160	0.1716

Figure 2 Yearly Naphthalene Stack Emissions



APPENDIX B

Appendix B

BPIP File Structure for Downwash Calculations

Buildings considered in the BPIP calculations were multitiered. Each tier corner's location was identified by a pair of X - and Y - Cartesian or respective UTM coordinates.

Each stack or source structure name used was the same name as used for the source emissions data in the respective ISC3 input runstream. The ISC3 programs restrict the stack or source name to a maximum 8 characters and so does BPIP. A stack base elevation and stack height were determined for each stack along with its X - and Y - Cartesian or UTM Easting and Northing coordinates. The direction for UTM 'north' is assumed to be the same as True North, but there can be a slight difference that the user can adjust for by setting a value other than 360.0 for 'plant north'.

The case study plant plots are not oriented to True North. The direction of 'plant north' was determine with respect to True North. BPIP will adjust the plant coordinates to True North coordinates after any UTM adjustments are made but before any GEP processing begins. Once this data has been determined, an input file to BPIP was written (Table 5.1a) Data entry is in 'Free Format'.

Table 5.1a Input file for BPIP calculations

```
'Foundry Building'
'ST'
'METERS' 1.0
'UTMY' 105.5
2
'L - Blg' 1 10.0
8  8.9
78988.27  1465971.17
79045.96  1465897.87
79027.74  1465879.18
79031.94  1465875.03
78993.47  1465835.05
78972.68  1465855.82
78990.86  1465868.64
78935.80  1465922.58
'S -Blg' 1  10.0
6 5.0
78661.08  1465888.45
78661.08  1465821.70
78911.86  1465811.16
78911.86  1465898.81
78934.17  1465898.81
78934.17  1465887.99
13
'FFF5845'  18.90  25.91  78988.27  1465971.17
'FFF5946'  18.90  22.86  79045.96  1465897.87
'FFF6047'  18.90  22.86  79027.74  1465879.18
'FSC1953'   3.96  39.01  78990.86  1465868.64
'FSC2155'   3.96  39.01  78942.40  1465915.51
'FSC2256'   3.96  39.01  78950.84  1465924.35
'FEF5437'  18.9   21.95  78992.81  1465954.39
'FEF5640'  18.9   21.34  78985.52  1465927.83
'FSC2783'  16.76  19.51  78983.10  1465925.39
'FEF2094'  13.11  22.86  78982.36  1465926.01
'FEF1774'   9.14  14.94  78999.81  1465920.28
'FSC3199'  13.11  19.51  78992.55  1465920.28
'FSC32100' 13.11  20.12  78993.86  1465921.74
0
```

Init

BPII

incre

proce

value

defini

is set

14 stac

parame

InitialP

- MB
- MT
- MB
- MT
- MSI
- MD
- ML

BPIP wi

was writ

No OPE

Executi

Initial Program Settings

BPIP has been programmed with parameters that the user can set to accommodate increases in the number of structures, tiers per structure, or stacks that need to be processed without changing the dimensions of over two dozen arrays. The parameter values are arguments in PARAMETER statements that are located shortly after the definitions in the main program and at the beginning of each subroutine. Initially, BPIP is set up to process a maximum of 8 buildings with a maximum of 4 tiers per building and 14 stack locations. In order to change the dimensions of these variables, the following parameters need to be changed:

InitialParameter	Definition	Setting
• MB	Maximum Number of Buildings	8
• MT	Maximum Number of Tiers/Building	4
• MBT	Maximum Building-Tier Number (MB*MT)	32
• MTS	Maximum Number of Sides/Tier	8
• MSK	Maximum Number of Stacks	14
• MD	Number of Sectors - ISCST2	36
• ML	Number of Sectors - ISCLT2	16

BPIP will need to be recompiled after changing any one of the above parameters. BPIP was written to Fortran 77 standards and compiled with Microsoft's Fortran 5.0 compiler. No OPEN statements were used in the source code.

Execution of BPIP

On

The

BPIP

BPIP

BPIP

data su

ISCST

file see

which

Once the input file has been prepared and saved to disk, BPIP is ready to be executed. The execution line is as follows:

BPIP input_filename output_filename summary_filename

BPIP output files and formats

BPIP runs generate two output files. A primary output file contains the essential output data such as the preliminary GEP stack height values and the BH and PBW for an ISCST2 or ISCLT2 input runstream file. This file is considered to be the primary output file see Table 5. A second file is a summary file and it contains detailed output such as which tier(s) are affecting which stack for a particular wind flow direction (Table 5.1b).

Table 5.1b BPIP Output file

BPIP (Dated: 95086)

DATE : 3/ 5/97
TIME : 23:13:52

Foundry Building

BPIP output is in meters

```
SO BUILDHGT FFF5845    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF5845    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF5845    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF5845    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF5845    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF5845    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDWID FFF5845  135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FFF5845   84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FFF5845  110.49 106.16 102.48 113.84 125.10 132.56
SO BUILDWID FFF5845  135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FFF5845   84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FFF5845  110.49 106.16 102.48 113.84 125.10 132.56

SO BUILDHGT FFF5946    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF5946    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF5946    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF5946    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF5946    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF5946    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDWID FFF5946  135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FFF5946   84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FFF5946  110.49 106.16 102.48 113.84 125.10 132.56
SO BUILDWID FFF5946  135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FFF5946   84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FFF5946  110.49 106.16 102.48 113.84 125.10 132.56

SO BUILDHGT FFF6047    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF6047    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF6047    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF6047    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF6047    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FFF6047    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDWID FFF6047  135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FFF6047   84.08  88.79  99.55 107.28 111.76 112.84
```

SO	BUILDWID	FFF6047	110.49	106.16	102.48	113.84	125.10	132.56
SO	BUILDWID	FFF6047	135.99	135.29	130.48	121.71	109.23	93.44
SO	BUILDWID	FFF6047	84.08	88.79	99.55	107.28	111.76	112.84
SO	BUILDWID	FFF6047	110.49	106.16	102.48	113.84	125.10	132.56
SO	BUILDHGT	FSC1953	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC1953	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC1953	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC1953	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC1953	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC1953	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDWID	FSC1953	135.99	135.29	130.48	121.71	109.23	93.44
SO	BUILDWID	FSC1953	84.08	88.79	99.55	107.28	111.76	112.84
SO	BUILDWID	FSC1953	110.49	106.16	102.48	113.84	125.10	132.56
SO	BUILDWID	FSC1953	135.99	135.29	130.48	121.71	109.23	93.44
SO	BUILDWID	FSC1953	84.08	88.79	99.55	107.28	111.76	112.84
SO	BUILDWID	FSC1953	110.49	106.16	102.48	113.84	125.10	132.56
SO	BUILDHGT	FSC2155	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC2155	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC2155	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC2155	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC2155	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC2155	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDWID	FSC2155	135.99	135.29	130.48	121.71	109.23	93.44
SO	BUILDWID	FSC2155	84.08	88.79	99.55	107.28	111.76	112.84
SO	BUILDWID	FSC2155	110.49	106.16	102.48	113.84	125.10	132.56
SO	BUILDWID	FSC2155	135.99	135.29	130.48	121.71	109.23	93.44
SO	BUILDWID	FSC2155	84.08	88.79	99.55	107.28	111.76	112.84
SO	BUILDWID	FSC2155	110.49	106.16	102.48	113.84	125.10	132.56
SO	BUILDHGT	FSC2256	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC2256	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC2256	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC2256	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC2256	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDHGT	FSC2256	8.90	8.90	8.90	8.90	8.90	8.90
SO	BUILDWID	FSC2256	135.99	135.29	130.48	121.71	109.23	93.44
SO	BUILDWID	FSC2256	84.08	88.79	99.55	107.28	111.76	112.84
SO	BUILDWID	FSC2256	110.49	106.16	102.48	113.84	125.10	132.56
SO	BUILDWID	FSC2256	135.99	135.29	130.48	121.71	109.23	93.44
SO	BUILDWID	FSC2256	84.08	88.79	99.55	107.28	111.76	112.84
SO	BUILDWID	FSC2256	110.49	106.16	102.48	113.84	125.10	132.56

```
SO BUILDHGT FEF5437   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF5437   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF5437   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF5437   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF5437   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF5437   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDWID FEF5437 135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FEF5437  84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FEF5437 110.49 106.16 102.48 113.84 125.10 132.56
SO BUILDWID FEF5437 135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FEF5437  84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FEF5437 110.49 106.16 102.48 113.84 125.10 132.56

SO BUILDHGT FEF5640   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF5640   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF5640   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF5640   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF5640   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF5640   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDWID FEF5640 135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FEF5640  84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FEF5640 110.49 106.16 102.48 113.84 125.10 132.56
SO BUILDWID FEF5640 135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FEF5640  84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FEF5640 110.49 106.16 102.48 113.84 125.10 132.56

SO BUILDHGT FSC2783   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC2783   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC2783   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC2783   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC2783   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC2783   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDWID FSC2783 135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FSC2783  84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FSC2783 110.49 106.16 102.48 113.84 125.10 132.56
SO BUILDWID FSC2783 135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FSC2783  84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FSC2783 110.49 106.16 102.48 113.84 125.10 132.56

SO BUILDHGT FEF2094   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF2094   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF2094   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF2094   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF2094   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF2094   8.90   8.90   8.90   8.90   8.90   8.90
```

```
SO BUILDWID FEF2094  135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FEF2094   84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FEF2094  110.49 106.16 102.48 113.84 125.10 132.56
SO BUILDWID FEF2094  135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FEF2094   84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FEF2094  110.49 106.16 102.48 113.84 125.10 132.56

SO BUILDHGT FEF1774    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF1774    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF1774    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF1774    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF1774    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FEF1774    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDWID FEF1774  135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FEF1774   84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FEF1774  110.49 106.16 102.48 113.84 125.10 132.56
SO BUILDWID FEF1774  135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FEF1774   84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FEF1774  110.49 106.16 102.48 113.84 125.10 132.56

SO BUILDHGT FSC3199    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC3199    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC3199    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC3199    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC3199    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC3199    8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDWID FSC3199  135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FSC3199   84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FSC3199  110.49 106.16 102.48 113.84 125.10 132.56
SO BUILDWID FSC3199  135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FSC3199   84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FSC3199  110.49 106.16 102.48 113.84 125.10 132.56

SO BUILDHGT FSC32100   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC32100   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC32100   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC32100   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC32100   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDHGT FSC32100   8.90   8.90   8.90   8.90   8.90   8.90
SO BUILDWID FSC32100 135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FSC32100  84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FSC32100 110.49 106.16 102.48 113.84 125.10 132.56
SO BUILDWID FSC32100 135.99 135.29 130.48 121.71 109.23  93.44
SO BUILDWID FSC32100  84.08  88.79  99.55 107.28 111.76 112.84
SO BUILDWID FSC32100 110.49 106.16 102.48 113.84 125.10 132.56
```

APPENDIX C

NOTE: MET
IS INCLUDED

*** U

	STAB CATE
A	.70000E
B	.70000E
C	.10000E
D	.15000E
E	.35000E
F	.55000E

	STAB CATE
A	.00000E
B	.00000E
C	.00000E
D	.00000E
E	.20000E-
F	.35000E-

Appendix C

Sample of Meteorological Data

PROCESSED BETWEEN
START DATE: 91 / 1 / 1 /1 AND END DATE: 91/ 12 /31/ 24

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

FILE:
SURF

LENGTH Z-(
YEAR MONT
(mm/HR)

91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1
91	1

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: C:\AC\SIMULA~1\MET1\MBS91_T.TRI FORMAT: UNFORM
SURFACE STATION NO.: 72639 UPPER AIR STATION NO.: 14826
NAME: UNKNOWN NAME: UNKNOWN
YEAR: 1991 YEAR: 1991

FLOW SPEED TEMP STAB MIXING HEIGHT (M) USTAR M-O
LENGTH Z-0 IPCODE PRATE
YEAR MONTH DAY HOUR VECTOR (M/S) (K) CLASS RURAL URBAN (M/S) (M) (M)
(mm/HR)

- -

91	1	1	1	351.0	4.63	264.3	4	742.9	742.9	.0000	.0	.0000	0	.00
91	1	1	2	8.0	4.63	265.4	4	729.9	729.9	.0000	.0	.0000	0	.00
91	1	1	3	24.0	4.12	265.9	4	716.9	716.9	.0000	.0	.0000	0	.00
91	1	1	4	23.0	5.66	265.9	4	703.9	703.9	.0000	.0	.0000	0	.00
91	1	1	5	13.0	5.66	265.9	4	691.0	691.0	.0000	.0	.0000	0	.00
91	1	1	6	22.0	6.17	265.9	4	678.0	678.0	.0000	.0	.0000	0	.00
91	1	1	7	15.0	5.14	266.5	4	665.0	665.0	.0000	.0	.0000	0	.00
91	1	1	8	13.0	3.09	267.0	5	652.0	426.0	.0000	.0	.0000	0	.00
91	1	1	9	347.0	3.60	266.5	4	74.1	445.1	.0000	.0	.0000	0	.00
91	1	1	10	1.0	5.14	267.6	4	174.1	470.9	.0000	.0	.0000	0	.00
91	1	1	11	354.0	5.14	268.7	4	274.0	496.7	.0000	.0	.0000	0	.00
91	1	1	12	346.0	6.17	269.3	4	374.0	522.4	.0000	.0	.0000	0	.00
91	1	1	13	3.0	6.17	270.9	4	474.0	548.2	.0000	.0	.0000	0	.00
91	1	1	14	9.0	4.12	270.9	4	574.0	574.0	.0000	.0	.0000	0	.00
91	1	1	15	32.0	5.66	272.6	4	574.0	574.0	.0000	.0	.0000	0	.00
91	1	1	16	24.0	6.69	272.0	4	574.0	574.0	.0000	.0	.0000	0	.00
91	1	1	17	1.0	4.12	271.5	4	574.0	574.0	.0000	.0	.0000	0	.00
91	1	1	18	27.0	5.14	271.5	4	579.5	579.5	.0000	.0	.0000	0	.00
91	1	1	19	54.0	6.17	272.0	4	585.4	585.4	.0000	.0	.0000	0	.00
91	1	1	20	57.0	4.63	272.0	4	591.2	591.2	.0000	.0	.0000	0	.00
91	1	1	21	80.0	2.06	271.5	4	597.1	597.1	.0000	.0	.0000	0	.00
91	1	1	22	92.0	5.14	272.6	4	603.0	603.0	.0000	.0	.0000	0	.00
91	1	1	23	80.0	4.12	272.6	4	608.9	608.9	.0000	.0	.0000	0	.00
91	1	1	24	100.0	5.66	272.0	4	614.7	614.7	.0000	.0	.0000	0	.00

APPENDIX D

Appendix D

Sample of Dispersion Simulations Input File

```
ISCST3 - (DATED 96113)
IBM-PC VERSION (3.04)    ISCST3R
 Run Began on  2/21/1998 at 10:21:11

 ** BREEZE AIR ISCST3 - C:\AC\SIMULA~1\SIM\FULL\FULL91.DAT
 ** Trinity Consultants Incorporated, Dallas, TX

 CO STARTING
 CO TITLEONE  TRIAL
 CO MODELOPT  DFAULT  CONC  RURAL
 CO AVERTIME  24  ANNUAL
 CO POLLUTID  BENZENE
 CO TERRHGTS  FLAT
 CO RUNORNOT  RUN
 CO FINISHED

 SO STARTING
 SO ELEVUNIT  METERS
 SO LOCATION  FFF5845  POINT  78971.8  1465950.8  18.9
 ** SRCDESCR  POURING1
 SO LOCATION  FFF5946  POINT  78967.02  1465949.34  18.9
 ** SRCDESCR  COOLING11
 SO LOCATION  FFF6047  POINT  78964.3  1465946.4  18.9
 ** SRCDESCR  COOLING12
 SO LOCATION  FSC1953  POINT  78958.68  1465938.8  3.96
 ** SRCDESCR  SHAKEOUT11
 SO LOCATION  FSC2155  POINT  78963.3  1465939.83  3.96
 ** SRCDESCR  SHAKEOUT12
 SO LOCATION  FSC2256  POINT  78965.25  1465937.83  3.96
 ** SRCDESCR  SHAKEOUT13
 SO LOCATION  FEF5437  POINT  78992.81  1465954.39  18.9
 ** SRCDESCR  POURING-RMIP2
 SO LOCATION  FEF5640  POINT  78985.52  1465927.83  18.9
 ** SRCDESCR  MAIN PURING2
 SO LOCATION  FSC2783  POINT  78983.1  1465925.39  16.76
 ** SRCDESCR  COOLING2
 SO LOCATION  FEF2094  POINT  78982.36  1465926.01  13.11
 ** SRCDESCR  SHAKEOUT2
 SO LOCATION  FEF1774  POINT  78999.81  1465920.28  9.14
 ** SRCDESCR  MAIN POURING3
 SO LOCATION  FSC3199  POINT  78992.55  1465920.28  13.11
 ** SRCDESCR  SHAKEOUT3
 SO LOCATION  FSC32100  POINT  78993.86  1465921.74  13.11
 ** SRCDESCR  COOLING3
 SO SRCPARAM  FFF5845  8.681209E-02  25.91  302.5889  26.68  1.22
 SO SRCPARAM  FFF5946  6.205366E-01  22.86  310.9278  8.98  1.07
 SO SRCPARAM  FFF6047  6.205366E-01  22.86  310.9278  12.14  1.07
 SO SRCPARAM  FSC1953  1.319192E-01  39.01  310.9278  16.9  1.07
 SO SRCPARAM  FSC2155  1.319192E-01  39.01  310.9278  16.98  1.22
 SO SRCPARAM  FSC2256  1.319192E-01  39.01  310.9278  16.98  1.22
```

```
SO SRCPARAM FEF5437 1.335578E-02 21.95 302.5889 49.7 0.76
SO SRCPARAM FEF5640 1.335578E-02 21.34 302.5889 21.83 1.22
SO SRCPARAM FSC2783 3.817736E-01 19.51 310.9278 16.17 1.22
SO SRCPARAM FEF2094 1.215880E-01 22.86 373.15 17.25 0.91
SO SRCPARAM FEF1774 1.335578E-02 14.94 302.5889 19.41 1.22
SO SRCPARAM FSC3199 6.079398E-02 19.51 310.9278 16.17 1.22
SO SRCPARAM FSC32100 1.908868E-01 20.12 310.9278 10.11 1.22
SO BUILDHGT FFF5946 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FFF5946 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FFF5946 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FFF5946 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FFF5946 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FFF5946 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDWID FFF5946 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FFF5946 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FFF5946 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDWID FFF5946 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FFF5946 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FFF5946 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDHGT FSC1953 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC1953 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC1953 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC1953 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC1953 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC1953 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDWID FSC1953 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC1953 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC1953 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDWID FSC1953 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC1953 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC1953 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDHGT FSC2155 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2155 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2155 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2155 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2155 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2155 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDWID FSC2155 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC2155 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC2155 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDWID FSC2155 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC2155 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC2155 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDHGT FSC2256 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2256 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2256 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2256 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2256 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2256 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDWID FSC2256 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC2256 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC2256 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDWID FSC2256 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC2256 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC2256 110.49 106.17 102.48 113.83 125.09 132.55
```

SO BUILDHGT FEF5437 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF5437 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF5437 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF5437 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF5437 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF5437 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDWID FEF5437 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FEF5437 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FEF5437 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDWID FEF5437 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FEF5437 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FEF5437 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDHGT FEF5640 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF5640 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF5640 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF5640 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF5640 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF5640 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDWID FEF5640 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FEF5640 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FEF5640 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDWID FEF5640 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FEF5640 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FEF5640 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDHGT FSC2783 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2783 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2783 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2783 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2783 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC2783 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDWID FSC2783 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC2783 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC2783 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDWID FSC2783 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC2783 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC2783 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDHGT FEF2094 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF2094 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF2094 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF2094 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF2094 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF2094 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDWID FEF2094 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FEF2094 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FEF2094 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDWID FEF2094 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FEF2094 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FEF2094 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDHGT FEF1774 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF1774 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF1774 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF1774 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF1774 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FEF1774 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDWID FEF1774 135.98 135.28 130.47 121.69 109.22 93.43

```
SO BUILDWID FEF1774 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FEF1774 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDWID FEF1774 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FEF1774 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FEF1774 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDHGT FSC3199 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC3199 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC3199 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC3199 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC3199 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC3199 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDWID FSC3199 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC3199 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC3199 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDWID FSC3199 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC3199 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC3199 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDHGT FSC32100 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC32100 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC32100 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC32100 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC32100 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDHGT FSC32100 10.0 10.0 10.0 10.0 10.0 10.0
SO BUILDWID FSC32100 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC32100 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC32100 110.49 106.17 102.48 113.83 125.09 132.55
SO BUILDWID FSC32100 135.98 135.28 130.47 121.69 109.22 93.43
SO BUILDWID FSC32100 84.09 88.79 99.55 107.28 111.76 112.84
SO BUILDWID FSC32100 110.49 106.17 102.48 113.83 125.09 132.55
SO EMISFACT FFF5845 HROFDY 0.08681 0.08681 0.08681 0.08681 0.08681 0.08681
SO EMISFACT FFF5845 HROFDY 0.08681 0.08681 0.08681 0.08681 0.08681 0.08681
SO EMISFACT FFF5845 HROFDY 0.08681 0.08681 0.08681 0.08681 0.08681 0.08681
SO EMISFACT FFF5845 HROFDY 0.08681 0.08681 0.08681 0.08681 0.08681 0.08681
SO EMISFACT FFF5946 HROFDY 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205
SO EMISFACT FFF5946 HROFDY 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205
SO EMISFACT FFF5946 HROFDY 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205
SO EMISFACT FFF5946 HROFDY 0.6205 0.6205 0.6205
SO EMISFACT FFF6047 HROFDY 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205
SO EMISFACT FFF6047 HROFDY 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205
SO EMISFACT FFF6047 HROFDY 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205 0.6205
SO EMISFACT FFF6047 HROFDY 0.6205 0.6205 0.6205
SO EMISFACT FSC1953 HROFDY 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319
SO EMISFACT FSC1953 HROFDY 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319
SO EMISFACT FSC1953 HROFDY 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319
SO EMISFACT FSC1953 HROFDY 0.1319 0.1319 0.1319
SO EMISFACT FSC2155 HROFDY 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319
SO EMISFACT FSC2155 HROFDY 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319
SO EMISFACT FSC2155 HROFDY 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319
SO EMISFACT FSC2155 HROFDY 0.1319 0.1319 0.1319
SO EMISFACT FSC2256 HROFDY 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319
SO EMISFACT FSC2256 HROFDY 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319
SO EMISFACT FSC2256 HROFDY 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319 0.1319
SO EMISFACT FSC2256 HROFDY 0.1319 0.1319 0.1319
SO EMISFACT FEF5437 HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
SO EMISFACT FEF5437 HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
```

```
SO EMISFACT  FEF5437  HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
SO EMISFACT  FEF5437  HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
SO EMISFACT  FEF5640  HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
SO EMISFACT  FEF5640  HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
SO EMISFACT  FEF5640  HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
SO EMISFACT  FEF5640  HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
SO EMISFACT  FSC2783  HROFDY 0.38177 0.38177 0.38177 0.38177 0.38177 0.38177
SO EMISFACT  FSC2783  HROFDY 0.38177 0.38177 0.38177 0.38177 0.38177 0.38177
SO EMISFACT  FSC2783  HROFDY 0.38177 0.38177 0.38177 0.38177 0.38177 0.38177
SO EMISFACT  FSC2783  HROFDY 0.38177 0.38177 0.38177 0.38177 0.38177 0.38177
SO EMISFACT  FEF2094  HROFDY 0.12159 0.12159 0.12159 0.12159 0.12159 0.12159
SO EMISFACT  FEF2094  HROFDY 0.12159 0.12159 0.12159 0.12159 0.12159 0.12159
SO EMISFACT  FEF2094  HROFDY 0.12159 0.12159 0.12159 0.12159 0.12159 0.12159
SO EMISFACT  FEF2094  HROFDY 0.12159 0.12159 0.12159 0.12159 0.12159 0.12159
SO EMISFACT  FEF1774  HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
SO EMISFACT  FEF1774  HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
SO EMISFACT  FEF1774  HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
SO EMISFACT  FEF1774  HROFDY 0.01336 0.01336 0.01336 0.01336 0.01336 0.01336
SO EMISFACT  FSC3199  HROFDY 0.06079 0.06079 0.06079 0.06079 0.06079 0.06079
SO EMISFACT  FSC3199  HROFDY 0.06079 0.06079 0.06079 0.06079 0.06079 0.06079
SO EMISFACT  FSC3199  HROFDY 0.06079 0.06079 0.06079 0.06079 0.06079 0.06079
SO EMISFACT  FSC3199  HROFDY 0.06079 0.06079 0.06079 0.06079 0.06079 0.06079
SO EMISFACT  FSC32100  HROFDY 0.19089 0.19089 0.19089 0.19089 0.19089 0.19089
SO EMISFACT  FSC32100  HROFDY 0.19089 0.19089 0.19089 0.19089 0.19089 0.19089
SO EMISFACT  FSC32100  HROFDY 0.19089 0.19089 0.19089 0.19089 0.19089 0.19089
SO EMISFACT  FSC32100  HROFDY 0.19089 0.19089 0.19089 0.19089 0.19089 0.19089
SO SRCGROUP  LINE1 FFF5845 FFF5946 FFF6047 FSC1953 FSC2155 FSC2256
SO SRCGROUP  LINE2 FEF5437 FEF5640 FSC2783 FEF2094
SO SRCGROUP  LINE3 FEF1774 FSC3199 FSC32100
SO SRCGROUP  LINE12 FFF5845 FFF5946 FFF6047 FSC1953 FSC2155 FSC2256 FEF5437
SO SRCGROUP  LINE12 FEF5640 FSC2783 FEF2094
SO SRCGROUP  LINE23 FEF5437 FEF5640 FSC2783 FEF2094 FEF1774 FSC3199 FSC32100
SO SRCGROUP  LINE13 FFF5845 FFF5946 FFF6047 FSC1953 FSC2155 FSC2256 FEF1774
SO SRCGROUP  LINE13 FSC3199 FSC32100
SO SRCGROUP  ALL
SO FINISHED

RE STARTING
RE GRIDCART CART1 STA
RE GRIDCART CART1 XYINC  78000  41  50  1465000  41  50
RE GRIDCART CART1 END
RE FINISHED

ME STARTING
ME INPUTFIL  C:\AC\SIMULA~1\MET1\MBS91_T.TRI  UNFORM
ME ANEMHGHT  10.0  METERS
ME SURFDATA  72639  1991
ME UAIRDATA  14826  1991
ME STARTEND  91  01  01  1  91  12  31  24
ME FINISHED

OU STARTING
OU RECTABLE  24  FIRST
OU FINISHED
*** SETUP Finishes Successfully ***
```

APPENDIX E

Appendix E

Sample of Dispersion Simulations Output File

Concentrations of Benzene for 1991

**THE ANNUAL (8760 HRS) AVERAGE CONCENTRATION VALUES
FOR SOURCE GROUP: LINE1 INCLUDING SOURCE(S):
FFF5845 , FFF5946 , FFF6047 , FSC1953 , FSC2155 , FSC2256 ,**

***** NETWORK ID: CART1 ; NETWORK TYPE: GRIDCART *****

**** CONC OF BENZENE IN MICROGRAMS/M**3 ****

Y-COORD (METERS)	X-COORD (METERS) 78000.00	78050.00	78100.00	78150.00	78200.00	78250.00	78300.00	78350.00	78400.00
1467000.00	.20165	.20159	.20113	.20271	.20765	.21596	.22656	.23768	.25089
1466950.00	.20941	.21100	.21069	.21037	.21254	.21831	.22736	.23832	.25052
1466900.00	.21737	.21979	.22102	.22045	.22032	.22314	.22970	.23934	.25085
1466850.00	.22730	.22890	.23098	.23176	.23090	.23102	.23451	.24175	.25191
1466800.00	.24004	.24015	.24141	.24304	.24326	.24209	.24250	.24662	.25439
1466750.00	.25578	.25447	.25418	.25498	.25603	.25554	.25402	.25473	.25892
1466700.00	.27427	.27216	.27032	.26948	.26970	.26996	.26859	.26610	.26626
1466650.00	.29442	.29297	.29029	.28772	.28618	.28560	.28417	.28079	.27737
1466600.00	.31440	.31548	.31385	.31042	.30685	.30374	.30120	.29779	.29244
1466550.00	.33326	.33747	.33906	.33728	.33234	.32640	.32133	.31671	.31068
1466500.00	.35110	.35796	.36318	.36522	.36237	.35535	.34674	.33891	.33136
1466450.00	.36621	.37646	.38503	.39080	.39291	.38940	.37996	.36746	.35555
1466400.00	.37683	.39082	.40312	.41280	.41959	.42222	.41813	.40571	.38786
1466350.00	.38488	.40113	.41644	.43019	.44135	.44903	.45190	.44721	.43155
1466300.00	.39085	.40884	.42636	.44311	.45819	.47025	.47807	.48025	.47416
1466250.00	.39016	.41095	.43151	.45140	.46999	.48629	.49890	.50579	.50512
1466200.00	.38125	.40330	.42623	.44952	.47232	.49341	.51143	.52438	.52962

1466150.00	.36690	.38861	.41150	.43538	.45978	.48412	.50705	.52651	.53957
1466100.00	.34595	.36674	.38875	.41181	.43555	.45958	.48300	.50451	.52207
1466050.00	.32258	.34086	.36021	.38051	.40149	.42284	.44382	.46333	.47966
1466000.00	.30747	.32348	.34016	.35734	.37466	.39176	.40788	.42196	.43252
1465950.00	.29729	.31193	.32705	.34243	.35771	.37246	.38590	.39694	.40406
1465900.00	.27850	.28991	.30120	.31204	.32195	.33034	.33630	.33868	.33599
1465850.00	.24101	.24695	.25205	.25597	.25832	.25870	.25667	.25184	.24397
1465800.00	.19636	.19904	.20129	.20311	.20453	.20568	.20659	.20722	.20738
1465750.00	.16558	.16931	.17343	.17797	.18293	.18831	.19425	.20119	.21000
1465700.00	.15249	.15818	.16450	.17170	.18025	.19084	.20414	.22007	.23646
1465650.00	.14916	.15722	.16699	.17899	.19344	.20974	.22585	.23842	.24474
1465600.00	.15476	.16693	.18081	.19576	.21006	.22147	.22857	.23187	.23259
1465550.00	.16749	.18084	.19301	.20280	.20946	.21364	.21667	.21854	.21781
1465500.00	.17607	.18453	.19048	.19457	.19817	.20176	.20423	.20498	.20757
1465450.00	.17247	.17630	.17997	.18389	.18775	.19039	.19240	.19772	.20981
1465400.00	.16287	.16661	.17091	.17474	.17742	.18053	.18767	.20063	.21484
1465350.00	.15503	.15907	.16251	.16545	.16952	.17776	.19073	.20414	.21246
1465300.00	.14845	.15141	.15434	.15921	.16817	.18067	.19305	.20099	.20558
1465250.00	.14147	.14452	.14979	.15874	.17060	.18207	.18949	.19387	.20119
1465200.00	.13581	.14135	.15007	.16093	.17118	.17816	.18246	.18856	.20130
1465150.00	.13374	.14209	.15198	.16112	.16741	.17130	.17654	.18709	.20427
1465100.00	.13474	.14372	.15187	.15754	.16105	.16542	.17397	.18825	.20802
1465050.00	.13609	.14338	.14849	.15167	.15535	.16236	.17410	.19082	.21103

Y-COORD | X-COORD (METERS)
(METERS) | 78450.00 78500.00 78550.00 78600.00 78650.00 78700.00 78750.00 78800.00 78850.00
- -

1467000.00	.27003	.29083	.30644	.31673	.33078	.35219	.36869	.37428	.37750
1466950.00	.26792	.29100	.31130	.32429	.33700	.35868	.37924	.38786	.39134
1466900.00	.26591	.28886	.31385	.33141	.34395	.36424	.38828	.40059	.40460
1466850.00	.26492	.28532	.31311	.33616	.35007	.36817	.39501	.41223	.41770
1466800.00	.26517	.28110	.30793	.33709	.35562	.37174	.39967	.42259	.43052
1466750.00	.26623	.27796	.30046	.33337	.35917	.37517	.40200	.43087	.44257
1466700.00	.26997	.27730	.29320	.32472	.35860	.37801	.40189	.43592	.45303
1466650.00	.27706	.28000	.28865	.31289	.35161	.37901	.39992	.43684	.46106
1466600.00	.28785	.28647	.28852	.30190	.33767	.37518	.39620	.43234	.46505
1466550.00	.30281	.29659	.29340	.29575	.31938	.36293	.39003	.42172	.46297
1466500.00	.32181	.31073	.30218	.29642	.30297	.34058	.37854	.40498	.45224
1466450.00	.34383	.32955	.31435	.30240	.29449	.31220	.35661	.38257	.42994
1466400.00	.36979	.35202	.33138	.31100	.29433	.28781	.32085	.35366	.39378
1466350.00	.40646	.37927	.35274	.32371	.29695	.27480	.27740	.31378	.34375
1466300.00	.45482	.42070	.38047	.34140	.30174	.26767	.24207	.25840	.28315
1466250.00	.49493	.47040	.42587	.36834	.31213	.26033	.21946	.19781	.21598
1466200.00	.52397	.50499	.47036	.41379	.33639	.25957	.19730	.15397	.14228
1466150.00	.54245	.53051	.49900	.44621	.37298	.27842	.18365	.11750	.08193
1466100.00	.53240	.53060	.51032	.46510	.39152	.29663	.19050	.09645	.04844
1466050.00	.49028	.49154	.47855	.44515	.38526	.29516	.18826	.09755	.03242
1466000.00	.43745	.43395	.41849	.38702	.33598	.26057	.17107	.08685	.02774
1465950.00	.40517	.39752	.37781	.34272	.29016	.21801	.13868	.06594	.01655
1465900.00	.32643	.30806	.27924	.23949	.19068	.13583	.08414	.04262	.01448
1465850.00	.23301	.21904	.20203	.18175	.15870	.13481	.10965	.06953	.02327
1465800.00	.20680	.20558	.20471	.20449	.19886	.17437	.12286	.06909	.04438
1465750.00	.22142	.23389	.24095	.23377	.20847	.16672	.12716	.10032	.09308
1465700.00	.24844	.25100	.24283	.22367	.19674	.17696	.15952	.15635	.14489

1465650.00 |	.24481	.23932	.22715	.21448	.21030	.20216	.20198	.20967	.19048
1465600.00 |	.22988	.22374	.22198	.22780	.22705	.22909	.24740	.24472	.22616
1465550.00 |	.21659	.22211	.23342	.23743	.24087	.26231	.27774	.26437	.25303
1465500.00 |	.21742	.23122	.23793	.24215	.26220	.28814	.28965	.27523	.27174
1465450.00 |	.22433	.23232	.23693	.25390	.28272	.29907	.29000	.28046	.28387
1465400.00 |	.22326	.22801	.24177	.26884	.29415	.29680	.28544	.28153	.29096
1465350.00 |	.21718	.22822	.25160	.27981	.29417	.28739	.27901	.27955	.29414
1465300.00 |	.21450	.23383	.26095	.28294	.28531	.27576	.27169	.27550	.29422
1465250.00 |	.21691	.24103	.26603	.27769	.27207	.26420	.26381	.27016	.29180
1465200.00 |	.22185	.24653	.26478	.26641	.25802	.25339	.25558	.26408	.28738
1465150.00 |	.22678	.24812	.25731	.25232	.24478	.24340	.24723	.25763	.28146
1465100.00 |	.22979	.24466	.24553	.23799	.23290	.23395	.23890	.25091	.27435
1465050.00 |	.22904	.23637	.23191	.22470	.22234	.22497	.23079	.24407	.26640
1465000.00 |	.22420	.22465	.21804	.21281	.21285	.21638	.22299	.23714	.25790

Y-COORD |	X-COORD (METERS)								
(METERS) |	78900.00	78950.00	79000.00	79050.00	79100.00	79150.00	79200.00	79250.00	79300.00
1467000.00 |	.38510	.38932	.38656	.38222	.38364	.39433	.40236	.39401	.37810
1466950.00 |	.39897	.40396	.40114	.39625	.39845	.41051	.41631	.40432	.38950
1466900.00 |	.41201	.41773	.41485	.40937	.41278	.42626	.42923	.41483	.40296
1466850.00 |	.42493	.43144	.42842	.42224	.42709	.44126	.44033	.42497	.41768
1466800.00 |	.43760	.44487	.44163	.43478	.44150	.45559	.45045	.43639	.43405
1466750.00 |	.44962	.45756	.45401	.44663	.45568	.46862	.45981	.44963	.45170
1466700.00 |	.46052	.46914	.46516	.45731	.46899	.47956	.46881	.46475	.46943
1466650.00 |	.46961	.47875	.47422	.46634	.48084	.48799	.47833	.48140	.48523
1466600.00 |	.47579	.48531	.48012	.47277	.48992	.49337	.48876	.49775	.49687
1466550.00 |	.47761	.48738	.48140	.47542	.49461	.49562	.49984	.51048	.50226

1466500.00 |	.47307	.48298	.47614	.47268	.49291	.49501	.50947	.51496	.50263
1466450.00 |	.45951	.46956	.46193	.46239	.48272	.49155	.51235	.50806	.50335
1466400.00 |	.43366	.44406	.43594	.44183	.46232	.48334	.50023	.49391	.50674
1466350.00 |	.39199	.40327	.39536	.40786	.43087	.46344	.46919	.48198	.50829
1466300.00 |	.33198	.34496	.33855	.35779	.38784	.41989	.43136	.47174	.51297
1466250.00 |	.25502	.27014	.26704	.29133	.32959	.35289	.40118	.46313	.52762
1466200.00 |	.16617	.18079	.18298	.20900	.24710	.29371	.37654	.46215	.54669
1466150.00 |	.08984	.10185	.10836	.12846	.16270	.25258	.35760	.45599	.52181
1466100.00 |	.03875	.04690	.05310	.06683	.12746	.22062	.31822	.39056	.42135
1466050.00 |	.01181	.02107	.02097	.05078	.10285	.16521	.22074	.27994	.34799
1466000.00 |	.00567	.00649	.01121	.02594	.05136	.09908	.16727	.25646	.34494
1465950.00 |	.00354	.00000	.00462	.01709	.03995	.08506	.15944	.25903	.35925
1465900.00 |	.00084	.00291	.00974	.02251	.03906	.08101	.14617	.23601	.32918
1465850.00 |	.00994	.01367	.01269	.02918	.06121	.10186	.17479	.27977	.36810
1465800.00 |	.03514	.04761	.04521	.05859	.08122	.12903	.21286	.30030	.38693
1465750.00 |	.07700	.09976	.09862	.09806	.12743	.16240	.22425	.32007	.40290
1465700.00 |	.12977	.16003	.15460	.14772	.17413	.21248	.24388	.29985	.39050
1465650.00 |	.18540	.22131	.20712	.19902	.21088	.23995	.27995	.30043	.34628
1465600.00 |	.23309	.26993	.24779	.24044	.23244	.26482	.28832	.32201	.33185
1465550.00 |	.27193	.30543	.27801	.26966	.25003	.27740	.29230	.31918	.34115
1465500.00 |	.30038	.32824	.29821	.28709	.26647	.27594	.29856	.30611	.33320
1465450.00 |	.31879	.34032	.30972	.29541	.27911	.27068	.29610	.30010	.31198
1465400.00 |	.32856	.34415	.31432	.29737	.28602	.26731	.28444	.29644	.29503
1465350.00 |	.33149	.34200	.31370	.29502	.28725	.26580	.27010	.28750	.28576
1465300.00 |	.32929	.33570	.30931	.28980	.28396	.26440	.25765	.27311	.27802
1465250.00 |	.32343	.32666	.30232	.28270	.27755	.26176	.24814	.25698	.26722
1465200.00 |	.31507	.31589	.29360	.27439	.26919	.25735	.24087	.24214	.25332

1465150.00	.30511	.30416	.28381	.26541	.25983	.25132	.23482	.22978	.23824
1465100.00	.29434	.29214	.27360	.25605	.24993	.24389	.22903	.21972	.22398
1465050.00	.28298	.27988	.26300	.24650	.23993	.23557	.22307	.21145	.21144
1465000.00	.27150	.26779	.25241	.23698	.23008	.22675	.21672	.20439	.20074

Y-COORD (METERS)	X-COORD (METERS) 79350.00	79400.00	79450.00	79500.00	79550.00	79600.00	79650.00	79700.00	79750.00
1467000.00	.37006	.36903	.36697	.36142	.35426	.34649	.33981	.33488	.32959
1466950.00	.38482	.38438	.38066	.37353	.36515	.35723	.35163	.34646	.34000
1466900.00	.40128	.40020	.39431	.38552	.37634	.36956	.36439	.35807	.35036
1466850.00	.41853	.41600	.40767	.39738	.38891	.38340	.37736	.36952	.36173
1466800.00	.43542	.43017	.42002	.41006	.40354	.39785	.39009	.38176	.37626
1466750.00	.45148	.44277	.43138	.42391	.41926	.41207	.40332	.39721	.39562
1466700.00	.46548	.45363	.44386	.43940	.43395	.42602	.41975	.41807	.41978
1466650.00	.47612	.46398	.45868	.45497	.44800	.44222	.44168	.44452	.44787
1466600.00	.48381	.47613	.47449	.46944	.46430	.46469	.46937	.47523	.48091
1466550.00	.49120	.49060	.48877	.48523	.48738	.49420	.50253	.51143	.51888
1466500.00	.50125	.50418	.50360	.50821	.51823	.53034	.54282	.55213	.55262
1466450.00	.51190	.51672	.52556	.54033	.55729	.57468	.58573	.58384	.56856
1466400.00	.52038	.53588	.55761	.58181	.60502	.61727	.61190	.59110	.56159
1466350.00	.53412	.56590	.60022	.63077	.64336	.63318	.60708	.57368	.53858
1466300.00	.55885	.60688	.64585	.65794	.64346	.61355	.57761	.54182	.50938
1466250.00	.59305	.64096	.65302	.63671	.60558	.56984	.53636	.50865	.48741
1466200.00	.60364	.61898	.60482	.57653	.54723	.52412	.50829	.49768	.48983
1466150.00	.54456	.53783	.52386	.51590	.51498	.51714	.51868	.51762	.51349
1466100.00	.43976	.46456	.49324	.51828	.53547	.54409	.54524	.54060	.53184
1466050.00	.41660	.47324	.51394	.53988	.55397	.55917	.55792	.55210	.54309

1466000.00	.42153	.48260	.52725	.55704	.57448	.58220	.58258	.57755	.56866
1465950.00	.44437	.51066	.55758	.58752	.60377	.60958	.60769	.60029	.58907
1465900.00	.41244	.48010	.53007	.56363	.58343	.59240	.59320	.58800	.57856
1465850.00	.43037	.47245	.50210	.52339	.53784	.54619	.54913	.54747	.54206
1465800.00	.46711	.52612	.55736	.56614	.56183	.55183	.54016	.52842	.51698
1465750.00	.46851	.52039	.56094	.58799	.59876	.59437	.57923	.55836	.53588
1465700.00	.46503	.51660	.54969	.57022	.58335	.59015	.58937	.58036	.56433
1465650.00	.42424	.48952	.53253	.55708	.56757	.56972	.56803	.56406	.55738
1465600.00	.36691	.43096	.48766	.52535	.54649	.55408	.55203	.54502	.53624
1465550.00	.34370	.36979	.42125	.47012	.50412	.52398	.53178	.53002	.52173
1465500.00	.34418	.34258	.36189	.40283	.44461	.47552	.49497	.50397	.50401
1465450.00	.33420	.33727	.33367	.34803	.38051	.41607	.44414	.46291	.47315
1465400.00	.31111	.32659	.32477	.32047	.33127	.35720	.38714	.41237	.43040
1465350.00	.28819	.30470	.31398	.30952	.30534	.31358	.33416	.35934	.38186
1465300.00	.27277	.28011	.29445	.29897	.29335	.28940	.29578	.31227	.33316
1465250.00	.26297	.26075	.27079	.28174	.28293	.27703	.27355	.27842	.29129
1465200.00	.25424	.24779	.24968	.26015	.26786	.26692	.26110	.25780	.26150
1465150.00	.24360	.23855	.23417	.23920	.24869	.25354	.25114	.24566	.24296
1465100.00	.23107	.22989	.22344	.22232	.22880	.23657	.23934	.23638	.23152
1465050.00	.21787	.22018	.21502	.20991	.21156	.21852	.22471	.22602	.22282
1465000.00	.20506	.20914	.20695	.20095	.19835	.20198	.20864	.21335	.21363

Y-COORD	X-COORD (METERS)				
(METERS)	79800.00	79850.00	79900.00	79950.00	80000.00
1467000.00	.32312	.31600	.31002	.30672	.30602
1466950.00	.33255	.32596	.32217	.32129	.32205
1466900.00	.34316	.33884	.33778	.33860	.33964
1466850.00	.35684	.35558	.35651	.35775	.35846
1466800.00	.37483	.37591	.37744	.37857	.37983
1466750.00	.39696	.39889	.40061	.40257	.40423
1466700.00	.42230	.42483	.42762	.42953	.42848

1466650.00 |	.45150	.45526	.45720	.45483	.44708
1466600.00 |	.48575	.48732	.48285	.47181	.45554
1466550.00 |	.51980	.51217	.49687	.47624	.45280
1466500.00 |	.54208	.52157	.49608	.46876	.44189
1466450.00 |	.54403	.51452	.48363	.45461	.42854
1466400.00 |	.52895	.49687	.46649	.43967	.41662
1466350.00 |	.50546	.47602	.45035	.42821	.41004
1466300.00 |	.48198	.45980	.44206	.42632	.41308
1466250.00 |	.47123	.45851	.44771	.43693	.42625
1466200.00 |	.48254	.47487	.46632	.45623	.44438
1466150.00 |	.50618	.49632	.48457	.47139	.45620
1466100.00 |	.52049	.50730	.49318	.47865	.46275
1466050.00 |	.53207	.51951	.50611	.49223	.47698
1466000.00 |	.55725	.54394	.52954	.51451	.49806
1465950.00 |	.57546	.56009	.54380	.52705	.50910
1465900.00 |	.56637	.55211	.53669	.52063	.50323
1465850.00 |	.53388	.52341	.51139	.49833	.48347
1465800.00 |	.50582	.49452	.48305	.47135	.45814
1465750.00 |	.51393	.49370	.47547	.45897	.44273
1465700.00 |	.54322	.51964	.49564	.47221	.44976
1465650.00 |	.54681	.53219	.51403	.49265	.46988
1465600.00 |	.52713	.51747	.50651	.49243	.47654
1465550.00 |	.51049	.49872	.48705	.47522	.46375
1465500.00 |	.49719	.48617	.47251	.45902	.44672
1465450.00 |	.47550	.47079	.46063	.44810	.43496
1465400.00 |	.44150	.44493	.44242	.43535	.42519
1465350.00 |	.39838	.40910	.41449	.41473	.41054
1465300.00 |	.35256	.36794	.37895	.38570	.38808
1465250.00 |	.30867	.32598	.34040	.35132	.35884
1465200.00 |	.27207	.28684	.30222	.31561	.32619
1465150.00 |	.24603	.25478	.26734	.28097	.29332
1465100.00 |	.22931	.23189	.23918	.24989	.26194
1465050.00 |	.21855	.21677	.21895	.22506	.23422
1465000.00 |	.21039	.20667	.20523	.20709	.21224

THE ANNUAL (8760 HRS) AVERAGE CONCENTRATION
VALUES FOR SOURCE GROUP: LINE2
INCLUDING SOURCE(S): FEF5437 , FEF5640 , FSC2783 , FEF2094 ,

***** NETWORK ID: CART1 ; NETWORK TYPE: GRIDCART *****

**** CONC OF BENZENE IN MICROGRAMS/M**3 ****

Y-COORD (METERS)	X-COORD (METERS) 78000.00	78050.00	78100.00	78150.00	78200.00	78250.00	78300.00	78350.00	78400.00
1467000.00	.03418	.03394	.03362	.03366	.03428	.03549	.03714	.03896	.04108
1466950.00	.03548	.03552	.03521	.03490	.03501	.03576	.03710	.03883	.04081
1466900.00	.03674	.03697	.03693	.03655	.03625	.03646	.03733	.03878	.04062
1466850.00	.03827	.03841	.03856	.03841	.03796	.03767	.03798	.03898	.04053
1466800.00	.04026	.04013	.04018	.04023	.03997	.03943	.03917	.03959	.04068
1466750.00	.04281	.04236	.04212	.04207	.04199	.04158	.04096	.04074	.04124
1466700.00	.04591	.04522	.04463	.04425	.04407	.04384	.04325	.04254	.04220
1466650.00	.04937	.04871	.04786	.04708	.04653	.04618	.04571	.04475	.04376
1466600.00	.05282	.05256	.05181	.05077	.04975	.04894	.04816	.04724	.04596
1466550.00	.05603	.05632	.05610	.05526	.05397	.05243	.05109	.04992	.04857
1466500.00	.05914	.05980	.06018	.06002	.05893	.05710	.05503	.05315	.05144
1466450.00	.06212	.06317	.06395	.06434	.06399	.06268	.06039	.05762	.05497
1466400.00	.06454	.06621	.06754	.06826	.06852	.06811	.06660	.06375	.06009
1466350.00	.06633	.06856	.07048	.07185	.07265	.07283	.07226	.07050	.06711
1466300.00	.06766	.07029	.07265	.07472	.07629	.07715	.07714	.07626	.07416
1466250.00	.06803	.07113	.07399	.07664	.07895	.08069	.08163	.08141	.07992
1466200.00	.06674	.07022	.07366	.07700	.08008	.08270	.08471	.08574	.08530
1466150.00	.06423	.06767	.07124	.07491	.07856	.08201	.08507	.08737	.08849

1466100.00	.06081	.06405	.06745	.07097	.07452	.07813	.08160	.08471	.08708
1466050.00	.05680	.05968	.06270	.06584	.06901	.07224	.07538	.07828	.08072
1466000.00	.05389	.05637	.05891	.06150	.06405	.06658	.06894	.07101	.07262
1465950.00	.05237	.05467	.05701	.05936	.06165	.06385	.06581	.06739	.06840
1465900.00	.04995	.05191	.05387	.05578	.05757	.05919	.06051	.06136	.06155
1465850.00	.04448	.04561	.04660	.04742	.04796	.04817	.04794	.04715	.04569
1465800.00	.03652	.03685	.03705	.03709	.03694	.03663	.03616	.03554	.03478
1465750.00	.02980	.03007	.03035	.03065	.03097	.03134	.03173	.03211	.03248
1465700.00	.02628	.02692	.02762	.02838	.02921	.03015	.03130	.03275	.03460
1465650.00	.02497	.02590	.02694	.02819	.02974	.03167	.03398	.03645	.03854
1465600.00	.02489	.02635	.02808	.03014	.03247	.03484	.03687	.03817	.03862
1465550.00	.02633	.02840	.03057	.03270	.03451	.03578	.03649	.03677	.03660
1465500.00	.02844	.03036	.03198	.03313	.03389	.03441	.03474	.03474	.03432
1465450.00	.02935	.03042	.03122	.03180	.03233	.03273	.03284	.03276	.03317
1465400.00	.02853	.02913	.02976	.03037	.03079	.03098	.03120	.03205	.03375
1465350.00	.02722	.02786	.02847	.02893	.02922	.02968	.03082	.03265	.03445
1465300.00	.02616	.02670	.02711	.02751	.02823	.02954	.03139	.03312	.03417
1465250.00	.02509	.02547	.02591	.02675	.02818	.03004	.03168	.03270	.03348
1465200.00	.02398	.02448	.02539	.02682	.02856	.03014	.03117	.03189	.03319
1465150.00	.02320	.02415	.02554	.02715	.02857	.02953	.03025	.03141	.03346
1465100.00	.02301	.02434	.02582	.02711	.02798	.02862	.02959	.03135	.03401
1465050.00	.02322	.02457	.02574	.02654	.02711	.02792	.02939	.03164	.03455
1465000.00	.02340	.02446	.02519	.02570	.02639	.02762	.02952	.03206	.03500

Y-COORD (METERS)	X-COORD (METERS) 78450.00	78500.00	78550.00	78600.00	78650.00	78700.00	78750.00	78800.00	78850.00
1467000.00	.04402	.04718	.04949	.05097	.05300	.05656	.05995	.06157	.06218

1466950.00	.04350	.04700	.05002	.05190	.05369	.05711	.06107	.06332	.06412
1466900.00	.04299	.04645	.05018	.05274	.05450	.05758	.06200	.06495	.06601
1466850.00	.04260	.04570	.04985	.05331	.05525	.05779	.06233	.06613	.06765
1466800.00	.04239	.04495	.04887	.05309	.05573	.05791	.06232	.06700	.06918
1466750.00	.04233	.04416	.04746	.05218	.05587	.05804	.06199	.06745	.07050
1466700.00	.04258	.04369	.04607	.05056	.05538	.05811	.06140	.06729	.07144
1466650.00	.04338	.04371	.04504	.04851	.05394	.05785	.06063	.06655	.07197
1466600.00	.04481	.04433	.04460	.04657	.05155	.05691	.05980	.06510	.07180
1466550.00	.04690	.04555	.04491	.04531	.04862	.05474	.05871	.06300	.07065
1466500.00	.04953	.04744	.04586	.04500	.04597	.05120	.05686	.06041	.06828
1466450.00	.05254	.04994	.04737	.04549	.04445	.04692	.05348	.05747	.06448
1466400.00	.05641	.05298	.04951	.04643	.04415	.04336	.04818	.05384	.05929
1466350.00	.06231	.05718	.05239	.04789	.04430	.04154	.04206	.04853	.05311
1466300.00	.07013	.06399	.05696	.05034	.04465	.04063	.03753	.04078	.04635
1466250.00	.07707	.07226	.06468	.05527	.04629	.03942	.03516	.03260	.03844
1466200.00	.08298	.07877	.07263	.06360	.05160	.03978	.03217	.02787	.02828
1466150.00	.08789	.08482	.07881	.07031	.05957	.04545	.03081	.02352	.01937
1466100.00	.08818	.08731	.08365	.07622	.06482	.05151	.03649	.01992	.01514
1466050.00	.08235	.08270	.08109	.07660	.06833	.05566	.03930	.02506	.01026
1466000.00	.07352	.07341	.07186	.06835	.06231	.05315	.04052	.02654	.01442
1465950.00	.06857	.06760	.06513	.06082	.05441	.04561	.03483	.02366	.01551
1465900.00	.06083	.05888	.05540	.05010	.04290	.03383	.02375	.01438	.00808
1465850.00	.04347	.04046	.03670	.03236	.02767	.02272	.01746	.01246	.00851
1465800.00	.03387	.03277	.03137	.02970	.02802	.02650	.02336	.01568	.00912
1465750.00	.03289	.03351	.03442	.03515	.03423	.02982	.02203	.01578	.01254
1465700.00	.03673	.03852	.03895	.03720	.03288	.02713	.02303	.02016	.02162
1465650.00	.03963	.03937	.03765	.03439	.03092	.02890	.02706	.02812	.02998

1465600.00	.03827	.03699	.03491	.03337	.03299	.03214	.03306	.03590	.03532
1465550.00	.03579	.03474	.03463	.03533	.03527	.03620	.03941	.04089	.03924
1465500.00	.03411	.03494	.03628	.03676	.03770	.04094	.04391	.04339	.04200
1465450.00	.03457	.03624	.03704	.03798	.04097	.04472	.04592	.04458	.04376
1465400.00	.03554	.03652	.03743	.04005	.04399	.04664	.04619	.04504	.04478
1465350.00	.03549	.03637	.03858	.04232	.04585	.04676	.04565	.04498	.04531
1465300.00	.03500	.03684	.04019	.04402	.04622	.04576	.04479	.04454	.04548
1465250.00	.03502	.03790	.04163	.04469	.04533	.04432	.04378	.04385	.04538
1465200.00	.03563	.03905	.04249	.04424	.04372	.04281	.04266	.04300	.04505
1465150.00	.03647	.03992	.04250	.04289	.04192	.04136	.04148	.04207	.04452
1465100.00	.03725	.04026	.04163	.04108	.04015	.03998	.04029	.04112	.04383
1465050.00	.03769	.03989	.04011	.03915	.03852	.03865	.03908	.04016	.04301
1465000.00	.03760	.03871	.03821	.03732	.03705	.03737	.03789	.03919	.04208

Y-COORD (METERS)	X-COORD (METERS) 78900.00	78950.00	79000.00	79050.00	79100.00	79150.00	79200.00	79250.00	79300.00
1467000.00	.06329	.06428	.06405	.06313	.06274	.06397	.06587	.06577	.06345
1466950.00	.06522	.06632	.06613	.06510	.06472	.06619	.06800	.06729	.06482
1466900.00	.06706	.06824	.06808	.06694	.06662	.06840	.07007	.06876	.06641
1466850.00	.06871	.06998	.06986	.06857	.06831	.07034	.07165	.06992	.06817
1466800.00	.07030	.07164	.07156	.07010	.06995	.07220	.07301	.07103	.07011
1466750.00	.07178	.07318	.07313	.07147	.07149	.07391	.07413	.07228	.07238
1466700.00	.07300	.07447	.07443	.07258	.07286	.07533	.07499	.07376	.07488
1466650.00	.07403	.07554	.07552	.07345	.07406	.07643	.07569	.07552	.07734
1466600.00	.07463	.07620	.07618	.07391	.07493	.07704	.07634	.07755	.07944
1466550.00	.07462	.07628	.07625	.07380	.07530	.07705	.07700	.07953	.08054
1466500.00	.07375	.07559	.07552	.07297	.07497	.07639	.07770	.08086	.08020

1466450.00 |	.07169	.07386	.07375	.07121	.07366	.07507	.07816	.08059	.07876
1466400.00 |	.06804	.07083	.07066	.06827	.07105	.07310	.07762	.07813	.07776
1466350.00 |	.06242	.06620	.06598	.06391	.06687	.07035	.07478	.07459	.07829
1466300.00 |	.05459	.05978	.05953	.05789	.06095	.06623	.06912	.07273	.07947
1466250.00 |	.04488	.05159	.05136	.05007	.05344	.05962	.06362	.07290	.08041
1466200.00 |	.03436	.04165	.04155	.04031	.04470	.05114	.06208	.07252	.08070
1466150.00 |	.02451	.03121	.03151	.02967	.03519	.04689	.06065	.07029	.08001
1466100.00 |	.01472	.02202	.02307	.02068	.03013	.04532	.05536	.06586	.07212
1466050.00 |	.00947	.01637	.01889	.01819	.03192	.03796	.04635	.05086	.05409
1466000.00 |	.00624	.01013	.01179	.03075	.02359	.02433	.03153	.04165	.05128
1465950.00 |	.01180	.00218	.00000	.01181	.02056	.02020	.02685	.03659	.04773
1465900.00 |	.00502	.00134	.00375	.01749	.01907	.01898	.02675	.03755	.04946
1465850.00 |	.00606	.00953	.00781	.01821	.02430	.02723	.03387	.04128	.04906
1465800.00 |	.00753	.01300	.01522	.01795	.01778	.02639	.03779	.04708	.05736
1465750.00 |	.01513	.01687	.02002	.01485	.02590	.02614	.03549	.04923	.05907
1465700.00 |	.02183	.02443	.02741	.02179	.02942	.03511	.03652	.04510	.05829
1465650.00 |	.02882	.03273	.03483	.03093	.03115	.03930	.04361	.04493	.05240
1465600.00 |	.03463	.04013	.04105	.03808	.03404	.04160	.04589	.04987	.05073
1465550.00 |	.03931	.04589	.04566	.04276	.03827	.04198	.04689	.05066	.05362
1465500.00 |	.04314	.05005	.04892	.04562	.04232	.04161	.04760	.04948	.05350
1465450.00 |	.04614	.05273	.05096	.04721	.04519	.04176	.04666	.04916	.05092
1465400.00 |	.04827	.05415	.05198	.04791	.04669	.04251	.04467	.04869	.04899
1465350.00 |	.04959	.05460	.05220	.04799	.04708	.04335	.04278	.04703	.04805
1465300.00 |	.05018	.05432	.05182	.04761	.04669	.04386	.04150	.04453	.04696
1465250.00 |	.05019	.05351	.05100	.04690	.04581	.04388	.04074	.04199	.04507
1465200.00 |	.04971	.05233	.04988	.04596	.04465	.04342	.04024	.03986	.04260
1465150.00 |	.04889	.05090	.04854	.04484	.04335	.04256	.03978	.03826	.04006

1465100.00	.04782	.04933	.04709	.04364	.04201	.04148	.03922	.03706	.03777
1465050.00	.04658	.04770	.04558	.04236	.04063	.04021	.03850	.03612	.03586
1465000.00	.04522	.04602	.04402	.04105	.03926	.03886	.03761	.03531	.03432

Y-COORD (METERS)	X-COORD (METERS) 79350.00	79400.00	79450.00	79500.00	79550.00	79600.00	79650.00	79700.00	79750.00
1467000.00	.06160	.06141	.06173	.06142	.06042	.05909	.05777	.05688	.05629
1466950.00	.06355	.06381	.06401	.06332	.06199	.06048	.05934	.05869	.05805
1466900.00	.06585	.06637	.06625	.06510	.06347	.06202	.06121	.06062	.05977
1466850.00	.06844	.06900	.06836	.06673	.06496	.06388	.06330	.06254	.06146
1466800.00	.07099	.07133	.07017	.06823	.06673	.06607	.06544	.06441	.06331
1466750.00	.07355	.07325	.07145	.06966	.06894	.06843	.06751	.06640	.06572
1466700.00	.07585	.07465	.07251	.07139	.07118	.07068	.06966	.06894	.06894
1466650.00	.07755	.07548	.07377	.07356	.07341	.07271	.07223	.07239	.07292
1466600.00	.07833	.07606	.07561	.07589	.07553	.07520	.07562	.07656	.07746
1466550.00	.07834	.07718	.07781	.07807	.07802	.07868	.07990	.08124	.08259
1466500.00	.07829	.07905	.08005	.08045	.08152	.08312	.08488	.08665	.08793
1466450.00	.07915	.08118	.08238	.08391	.08599	.08837	.09066	.09210	.09192
1466400.00	.08085	.08330	.08562	.08839	.09143	.09431	.09589	.09530	.09284
1466350.00	.08260	.08608	.08978	.09380	.09736	.09884	.09773	.09474	.09054
1466300.00	.08463	.08955	.09481	.09908	.10044	.09887	.09529	.09065	.08564
1466250.00	.08685	.09361	.09857	.09986	.09796	.09393	.08889	.08388	.07962
1466200.00	.08907	.09471	.09612	.09394	.08957	.08477	.08079	.07801	.07627
1466150.00	.08633	.08778	.08529	.08163	.07895	.07776	.07758	.07779	.07795
1466100.00	.07296	.07195	.07235	.07435	.07691	.07915	.08067	.08140	.08141
1466050.00	.05966	.06631	.07233	.07698	.08018	.08213	.08307	.08325	.08287
1466000.00	.05969	.06697	.07294	.07759	.08100	.08331	.08470	.08531	.08531

1465950.00 |	.05819	.06744	.07500	.08078	.08491	.08760	.08913	.08971	.08957
1465900.00 |	.06033	.06972	.07725	.08287	.08680	.08927	.09058	.09095	.09061
1465850.00 |	.05674	.06415	.07071	.07611	.08024	.08316	.08501	.08595	.08616
1465800.00 |	.06693	.07364	.07741	.07928	.08019	.08066	.08090	.08093	.08074
1465750.00 |	.06751	.07546	.08226	.08679	.08865	.08834	.08671	.08452	.08222
1465700.00 |	.06819	.07521	.08062	.08505	.08858	.09085	.09149	.09054	.08838
1465650.00 |	.06431	.07359	.07970	.08366	.08620	.08791	.08912	.08975	.08959
1465600.00 |	.05685	.06714	.07561	.08114	.08444	.08609	.08666	.08669	.08655
1465550.00 |	.05394	.05879	.06742	.07505	.08019	.08324	.08465	.08486	.08430
1465500.00 |	.05521	.05512	.05888	.06601	.07279	.07762	.08061	.08213	.08237
1465450.00 |	.05456	.05521	.05487	.05776	.06359	.06955	.07410	.07712	.07877
1465400.00 |	.05146	.05424	.05416	.05368	.05591	.06066	.06588	.07011	.07309
1465350.00 |	.04837	.05114	.05300	.05247	.05196	.05369	.05756	.06207	.06596
1465300.00 |	.04647	.04754	.05011	.05122	.05046	.04994	.05129	.05444	.05831
1465250.00 |	.04528	.04482	.04652	.04865	.04913	.04826	.04777	.04883	.05132
1465200.00 |	.04398	.04318	.04337	.04524	.04684	.04690	.04601	.04551	.04624
1465150.00 |	.04214	.04194	.04116	.04195	.04374	.04485	.04458	.04365	.04317
1465100.00 |	.03989	.04057	.03968	.03938	.04054	.04203	.04267	.04224	.04139
1465050.00 |	.03756	.03887	.03847	.03756	.03773	.03897	.04019	.04055	.04004
1465000.00 |	.03539	.03687	.03711	.03620	.03563	.03620	.03744	.03839	.03854

Y-COORD |	X-COORD (METERS)				
(METERS) |	79800.00	79850.00	79900.00	79950.00	80000.00
1467000.00 |	.05559	.05465	.05360	.05277	.05239
1466950.00 |	.05714	.05606	.05515	.05471	.05472
1466900.00 |	.05868	.05770	.05720	.05720	.05745
1466850.00 |	.06042	.05986	.05984	.06013	.06042
1466800.00 |	.06269	.06268	.06300	.06334	.06358
1466750.00 |	.06571	.06608	.06648	.06681	.06713
1466700.00 |	.06938	.06987	.07031	.07074	.07100
1466650.00 |	.07352	.07411	.07466	.07490	.07452
1466600.00 |	.07823	.07890	.07907	.07840	.07686
1466550.00 |	.08347	.08348	.08241	.08033	.07753

1466500.00 |	.08804	.08644	.08372	.08032	.07657
1466450.00 |	.09007	.08692	.08286	.07859	.07441
1466400.00 |	.08919	.08493	.08029	.07580	.07173
1466350.00 |	.08585	.08117	.07677	.07266	.06920
1466300.00 |	.08089	.07675	.07336	.07041	.06800
1466250.00 |	.07628	.07382	.07199	.07042	.06888
1466200.00 |	.07517	.07435	.07360	.07277	.07150
1466150.00 |	.07791	.07749	.07673	.07566	.07404
1466100.00 |	.08089	.07991	.07861	.07710	.07522
1466050.00 |	.08212	.08106	.07979	.07837	.07666
1466000.00 |	.08485	.08401	.08287	.08152	.07986
1465950.00 |	.08889	.08780	.08640	.08478	.08287
1465900.00 |	.08976	.08852	.08698	.08523	.08321
1465850.00 |	.08581	.08501	.08385	.08245	.08070
1465800.00 |	.08035	.07972	.07886	.07781	.07641
1465750.00 |	.08011	.07816	.07641	.07479	.07303
1465700.00 |	.08556	.08242	.07929	.07637	.07342
1465650.00 |	.08849	.08650	.08384	.08074	.07718
1465600.00 |	.08618	.08547	.08427	.08238	.07981
1465550.00 |	.08341	.08246	.08149	.08018	.07865
1465500.00 |	.08170	.08050	.07904	.07736	.07585
1465450.00 |	.07924	.07876	.07736	.07558	.07377
1465400.00 |	.07490	.07556	.07508	.07394	.07237
1465350.00 |	.06885	.07053	.07128	.07122	.07048
1465300.00 |	.06171	.06428	.06606	.06708	.06738
1465250.00 |	.05449	.05754	.06000	.06183	.06303
1465200.00 |	.04824	.05097	.05372	.05606	.05788
1465150.00 |	.04377	.04543	.04778	.05025	.05245
1465100.00 |	.04098	.04147	.04287	.04488	.04710
1465050.00 |	.03928	.03894	.03935	.04052	.04226
1465000.00 |	.03801	.03733	.03705	.03739	.03837

THE ANNUAL (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: LINE3
INCLUDING SOURCE(S): FEF1774 , FSC3199 , FSC32100,

***** NETWORK ID: CART1 ; NETWORK TYPE: GRIDCART *****

**** CONC OF BENZENE IN MICROGRAMS/M**3 ****

Y-COORD (METERS)	X-COORD (METERS) 78000.00	78050.00	78100.00	78150.00	78200.00	78250.00	78300.00	78350.00	78400.00
1467000.00	.01005	.01005	.01000	.01004	.01028	.01071	.01129	.01189	.01249
1466950.00	.01041	.01051	.01050	.01045	.01053	.01081	.01130	.01190	.01252
1466900.00	.01078	.01093	.01101	.01098	.01094	.01106	.01140	.01192	.01255
1466850.00	.01124	.01135	.01149	.01155	.01150	.01148	.01164	.01202	.01259
1466800.00	.01185	.01187	.01197	.01209	.01213	.01207	.01206	.01226	.01269
1466750.00	.01262	.01256	.01257	.01265	.01275	.01276	.01267	.01269	.01293
1466700.00	.01354	.01344	.01335	.01334	.01339	.01346	.01343	.01333	.01334
1466650.00	.01454	.01447	.01434	.01423	.01418	.01420	.01423	.01412	.01396
1466600.00	.01552	.01559	.01552	.01536	.01520	.01510	.01505	.01499	.01479
1466550.00	.01644	.01667	.01677	.01670	.01650	.01625	.01605	.01592	.01575
1466500.00	.01735	.01768	.01796	.01810	.01802	.01773	.01736	.01706	.01681
1466450.00	.01817	.01866	.01907	.01941	.01956	.01947	.01909	.01858	.01807
1466400.00	.01877	.01946	.02008	.02058	.02096	.02117	.02108	.02056	.01986
1466350.00	.01920	.02003	.02085	.02157	.02217	.02264	.02291	.02281	.02228
1466300.00	.01956	.02048	.02141	.02231	.02316	.02389	.02437	.02472	.02473
1466250.00	.01970	.02076	.02182	.02287	.02391	.02489	.02566	.02632	.02669
1466200.00	.01938	.02057	.02179	.02305	.02432	.02545	.02663	.02766	.02841
1466150.00	.01876	.01994	.02121	.02256	.02401	.02542	.02693	.02837	.02962
1466100.00	.01787	.01901	.02024	.02157	.02300	.02448	.02613	.02784	.02954

1466050.00 |	.01671	.01775	.01888	.02012	.02143	.02284	.02441	.02606	.02780
1466000.00 |	.01574	.01665	.01763	.01868	.01975	.02098	.02228	.02364	.02505
1465950.00 |	.01521	.01604	.01693	.01788	.01883	.01992	.02105	.02220	.02335
1465900.00 |	.01459	.01533	.01611	.01693	.01773	.01863	.01956	.02047	.02135
1465850.00 |	.01324	.01375	.01425	.01475	.01516	.01560	.01597	.01623	.01635
1465800.00 |	.01107	.01132	.01154	.01173	.01186	.01199	.01210	.01219	.01228
1465750.00 |	.00906	.00923	.00941	.00961	.00984	.01009	.01042	.01079	.01122
1465700.00 |	.00792	.00818	.00847	.00880	.00918	.00959	.01013	.01080	.01167
1465650.00 |	.00750	.00783	.00822	.00867	.00924	.00993	.01083	.01185	.01288
1465600.00 |	.00744	.00792	.00849	.00919	.01000	.01089	.01172	.01239	.01281
1465550.00 |	.00783	.00849	.00921	.00996	.01064	.01118	.01153	.01181	.01203
1465500.00 |	.00845	.00908	.00965	.01009	.01040	.01065	.01090	.01109	.01121
1465450.00 |	.00873	.00910	.00937	.00959	.00982	.01007	.01028	.01040	.01066
1465400.00 |	.00844	.00863	.00884	.00909	.00933	.00952	.00969	.01004	.01070
1465350.00 |	.00798	.00819	.00843	.00866	.00883	.00904	.00944	.01012	.01089
1465300.00 |	.00763	.00785	.00804	.00821	.00845	.00889	.00954	.01024	.01072
1465250.00 |	.00732	.00748	.00765	.00791	.00836	.00899	.00962	.01006	.01033
1465200.00 |	.00699	.00716	.00743	.00788	.00845	.00902	.00943	.00968	.01004
1465150.00 |	.00673	.00701	.00744	.00796	.00846	.00883	.00906	.00937	.00996
1465100.00 |	.00663	.00703	.00751	.00796	.00828	.00848	.00874	.00923	.01003
1465050.00 |	.00666	.00709	.00749	.00778	.00796	.00818	.00858	.00923	.01015
1465000.00 |	.00671	.00707	.00733	.00749	.00767	.00800	.00854	.00931	.01027

Y-COORD | (METERS) |	X-COORD (METERS) 78450.00	78500.00	78550.00	78600.00	78650.00	78700.00	78750.00	78800.00	78850.00
1467000.00 |	.01333	.01433	.01515	.01568	.01621	.01718	.01819	.01869	.01882
1466950.00 |	.01327	.01433	.01536	.01606	.01659	.01748	.01864	.01934	.01955

1466900.00	.01324	.01424	.01546	.01640	.01700	.01780	.01906	.01999	.02030
1466850.00	.01325	.01413	.01541	.01665	.01741	.01811	.01937	.02054	.02102
1466800.00	.01329	.01406	.01523	.01668	.01773	.01842	.01960	.02103	.02174
1466750.00	.01339	.01400	.01497	.01649	.01791	.01874	.01980	.02144	.02245
1466700.00	.01358	.01403	.01476	.01614	.01789	.01904	.01999	.02165	.02303
1466650.00	.01397	.01422	.01470	.01573	.01757	.01916	.02012	.02181	.02362
1466600.00	.01460	.01460	.01482	.01542	.01699	.01907	.02032	.02183	.02406
1466550.00	.01547	.01519	.01517	.01540	.01640	.01858	.02039	.02175	.02426
1466500.00	.01648	.01608	.01579	.01569	.01603	.01775	.02016	.02159	.02416
1466450.00	.01768	.01721	.01666	.01627	.01609	.01686	.01939	.02133	.02368
1466400.00	.01916	.01853	.01782	.01709	.01656	.01639	.01808	.02076	.02286
1466350.00	.02131	.02024	.01925	.01821	.01728	.01655	.01676	.01951	.02178
1466300.00	.02415	.02287	.02126	.01973	.01826	.01707	.01616	.01748	.02044
1466250.00	.02669	.02607	.02448	.02216	.01981	.01778	.01632	.01554	.01844
1466200.00	.02875	.02861	.02786	.02602	.02286	.01933	.01663	.01486	.01538
1466150.00	.03055	.03092	.03051	.02930	.02716	.02327	.01819	.01474	.01280
1466100.00	.03111	.03232	.03289	.03241	.03049	.02748	.02321	.01637	.01221
1466050.00	.02956	.03127	.03276	.03369	.03357	.03168	.02726	.02205	.01434
1466000.00	.02649	.02792	.02927	.03047	.03137	.03171	.03074	.02756	.02048
1465950.00	.02446	.02546	.02626	.02675	.02680	.02624	.02487	.02282	.02062
1465900.00	.02213	.02277	.02315	.02318	.02269	.02150	.01935	.01612	.01184
1465850.00	.01629	.01601	.01551	.01482	.01399	.01313	.01225	.01156	.01065
1465800.00	.01239	.01253	.01272	.01296	.01340	.01417	.01454	.01218	.00799
1465750.00	.01174	.01244	.01340	.01457	.01539	.01490	.01248	.01017	.01073
1465700.00	.01277	.01393	.01481	.01500	.01428	.01270	.01190	.01241	.01400
1465650.00	.01367	.01407	.01406	.01355	.01280	.01288	.01345	.01464	.01649
1465600.00	.01304	.01306	.01281	.01267	.01324	.01387	.01476	.01669	.01722

1465550.00 |	.01210	.01207	.01234	.01314	.01380	.01449	.01625	.01764	.01718
1465500.00 |	.01135	.01186	.01274	.01339	.01395	.01544	.01720	.01750	.01697
1465450.00 |	.01129	.01218	.01280	.01327	.01446	.01626	.01727	.01693	.01667
1465400.00 |	.01153	.01212	.01252	.01345	.01509	.01653	.01669	.01630	.01630
1465350.00 |	.01140	.01176	.01248	.01387	.01545	.01618	.01588	.01568	.01587
1465300.00 |	.01103	.01157	.01272	.01423	.01537	.01543	.01507	.01508	.01543
1465250.00 |	.01078	.01170	.01303	.01433	.01486	.01456	.01435	.01448	.01498
1465200.00 |	.01078	.01192	.01324	.01413	.01408	.01373	.01369	.01391	.01454
1465150.00 |	.01092	.01213	.01321	.01358	.01329	.01304	.01312	.01336	.01410
1465100.00 |	.01110	.01222	.01291	.01286	.01251	.01239	.01256	.01288	.01371
1465050.00 |	.01122	.01212	.01238	.01210	.01181	.01183	.01203	.01240	.01328
1465000.00 |	.01122	.01177	.01171	.01137	.01120	.01131	.01154	.01196	.01286

Y-COORD |	X-COORD (METERS)								
(METERS) |	78900.00	78950.00	79000.00	79050.00	79100.00	79150.00	79200.00	79250.00	79300.00
1467000.00 |	.01915	.01954	.01953	.01929	.01916	.01946	.02007	.02021	.01951
1466950.00 |	.01987	.02029	.02031	.02004	.01990	.02027	.02090	.02085	.02002
1466900.00 |	.02060	.02105	.02110	.02081	.02066	.02112	.02175	.02149	.02059
1466850.00 |	.02132	.02180	.02189	.02155	.02140	.02195	.02252	.02205	.02121
1466800.00 |	.02207	.02258	.02270	.02232	.02216	.02281	.02326	.02260	.02193
1466750.00 |	.02285	.02338	.02354	.02309	.02295	.02370	.02396	.02319	.02278
1466700.00 |	.02356	.02411	.02430	.02379	.02369	.02451	.02460	.02388	.02379
1466650.00 |	.02436	.02493	.02517	.02456	.02453	.02539	.02519	.02463	.02483
1466600.00 |	.02513	.02574	.02601	.02530	.02536	.02621	.02584	.02565	.02601
1466550.00 |	.02582	.02650	.02679	.02596	.02617	.02694	.02656	.02684	.02707
1466500.00 |	.02637	.02716	.02749	.02651	.02692	.02756	.02741	.02807	.02782
1466450.00 |	.02667	.02769	.02803	.02691	.02755	.02807	.02843	.02910	.02821

1466400.00 |	.02658	.02801	.02835	.02708	.02802	.02851	.02953	.02957	.02853
1466350.00 |	.02591	.02804	.02835	.02697	.02821	.02899	.03031	.02946	.02930
1466300.00 |	.02445	.02769	.02794	.02653	.02807	.02951	.03018	.02953	.03056
1466250.00 |	.02218	.02687	.02704	.02576	.02758	.02969	.02933	.03059	.03231
1466200.00 |	.01938	.02541	.02551	.02461	.02690	.02871	.02966	.03250	.03463
1466150.00 |	.01618	.02308	.02344	.02314	.02611	.02761	.03182	.03460	.03670
1466100.00 |	.01191	.01944	.02095	.02143	.02488	.02979	.03328	.03535	.03597
1466050.00 |	.00956	.01451	.01836	.02040	.02643	.03017	.03180	.03132	.02861
1466000.00 |	.01265	.00788	.01297	.02090	.02471	.02471	.02260	.02397	.02642
1465950.00 |	.01906	.00708	.00007	.01226	.01743	.01901	.02155	.02411	.02670
1465900.00 |	.00755	.00357	.00000	.01368	.02164	.02109	.02357	.02609	.02854
1465850.00 |	.00600	.00733	.00964	.01335	.01982	.02313	.02753	.02900	.02912
1465800.00 |	.00879	.01044	.01493	.01364	.01640	.02136	.02507	.02790	.03116
1465750.00 |	.01282	.01215	.01690	.01384	.01719	.01882	.02270	.02700	.02926
1465700.00 |	.01483	.01481	.01889	.01666	.01769	.01928	.02045	.02337	.02760
1465650.00 |	.01568	.01714	.02009	.01832	.01702	.01906	.02062	.02111	.02328
1465600.00 |	.01637	.01882	.02069	.01884	.01696	.01887	.01945	.02104	.02106
1465550.00 |	.01687	.01979	.02080	.01879	.01738	.01772	.01890	.01964	.02077
1465500.00 |	.01720	.02022	.02060	.01852	.01764	.01659	.01831	.01833	.01946
1465450.00 |	.01737	.02022	.02018	.01811	.01752	.01595	.01711	.01768	.01778
1465400.00 |	.01737	.01991	.01959	.01762	.01711	.01564	.01579	.01694	.01670
1465350.00 |	.01722	.01939	.01891	.01706	.01653	.01539	.01475	.01585	.01603
1465300.00 |	.01694	.01873	.01816	.01646	.01587	.01507	.01404	.01465	.01530
1465250.00 |	.01655	.01800	.01737	.01583	.01519	.01465	.01353	.01358	.01436
1465200.00 |	.01608	.01722	.01659	.01520	.01452	.01415	.01313	.01274	.01335
1465150.00 |	.01556	.01644	.01582	.01456	.01386	.01359	.01275	.01213	.01244
1465100.00 |	.01505	.01573	.01513	.01399	.01329	.01306	.01242	.01165	.01164

1465050.00 | .01449 .01500 .01442 .01339 .01270 .01249 .01201 .01125
.01100
1465000.00 | .01392 .01430 .01375 .01282 .01215 .01194 .01159 .01089
.01047

Y-COORD | X-COORD (METERS)
(METERS) | 79350.00 79400.00 79450.00 79500.00 79550.00 79600.00 79650.00
79700.00 79750.00
- -

1467000.00 | .01872 .01843 .01839 .01825 .01796 .01761 .01722 .01688
.01662
1466950.00 | .01935 .01921 .01917 .01894 .01858 .01816 .01776 .01747
.01720
1466900.00 | .02010 .02007 .01997 .01964 .01919 .01873 .01838 .01811
.01777
1466850.00 | .02097 .02099 .02078 .02033 .01981 .01938 .01908 .01876
.01835
1466800.00 | .02190 .02190 .02156 .02101 .02047 .02013 .01981 .01940
.01896
1466750.00 | .02290 .02277 .02226 .02165 .02125 .02094 .02054 .02007
.01972
1466700.00 | .02393 .02358 .02290 .02236 .02208 .02175 .02128 .02089
.02076
1466650.00 | .02491 .02428 .02357 .02322 .02294 .02252 .02214 .02201
.02208
1466600.00 | .02566 .02480 .02439 .02417 .02379 .02340 .02330 .02344
.02363
1466550.00 | .02629 .02551 .02528 .02508 .02473 .02464 .02483 .02512
.02542
1466500.00 | .02681 .02646 .02632 .02600 .02594 .02632 .02670 .02712
.02746
1466450.00 | .02755 .02756 .02740 .02743 .02780 .02835 .02896 .02934
.02924
1466400.00 | .02861 .02873 .02891 .02944 .03013 .03085 .03131 .03100
.02999
1466350.00 | .02985 .03032 .03108 .03201 .03291 .03322 .03258 .03127
.02950
1466300.00 | .03151 .03260 .03384 .03492 .03505 .03402 .03224 .03015
.02818
1466250.00 | .03386 .03546 .03663 .03646 .03500 .03286 .03052 .02833
.02654
1466200.00 | .03656 .03770 .03714 .03526 .03276 .03026 .02818 .02662
.02555
1466150.00 | .03764 .03667 .03427 .03153 .02935 .02793 .02707 .02652
.02607
1466100.00 | .03416 .03134 .02939 .02859 .02840 .02836 .02823 .02791
.02743
1466050.00 | .02762 .02822 .02917 .02982 .03004 .02989 .02946 .02885
.02813
1466000.00 | .02833 .02964 .03041 .03077 .03080 .03058 .03016 .02961
.02895
1465950.00 | .02884 .03051 .03163 .03224 .03241 .03223 .03180 .03118
.03044

1465900.00 |	.03047	.03191	.03281	.03323	.03323	.03292	.03237	.03165	.03082
1465850.00 |	.02927	.02973	.03026	.03066	.03082	.03075	.03045	.02997	.02936
1465800.00 |	.03316	.03345	.03265	.03151	.03043	.02951	.02875	.02807	.02742
1465750.00 |	.03119	.03288	.03395	.03407	.03330	.03196	.03042	.02892	.02757
1465700.00 |	.02998	.03135	.03218	.03268	.03287	.03265	.03195	.03082	.02943
1465650.00 |	.02710	.02958	.03085	.03137	.03141	.03120	.03088	.03041	.02976
1465600.00 |	.02264	.02587	.02831	.02962	.03014	.03009	.02969	.02914	.02863
1465550.00 |	.02051	.02164	.02427	.02656	.02792	.02854	.02859	.02822	.02769
1465500.00 |	.02003	.01964	.02046	.02256	.02461	.02599	.02671	.02699	.02678
1465450.00 |	.01890	.01905	.01862	.01921	.02088	.02267	.02405	.02489	.02526
1465400.00 |	.01721	.01808	.01796	.01754	.01798	.01930	.02091	.02218	.02304
1465350.00 |	.01583	.01655	.01712	.01685	.01648	.01686	.01793	.01925	.02042
1465300.00 |	.01497	.01508	.01580	.01611	.01584	.01553	.01579	.01664	.01777
1465250.00 |	.01434	.01402	.01445	.01507	.01519	.01485	.01459	.01479	.01547
1465200.00 |	.01372	.01339	.01330	.01379	.01426	.01426	.01393	.01371	.01385
1465150.00 |	.01295	.01285	.01251	.01264	.01313	.01346	.01337	.01306	.01286
1465100.00 |	.01212	.01227	.01195	.01177	.01204	.01247	.01267	.01254	.01226
1465050.00 |	.01133	.01163	.01148	.01116	.01113	.01146	.01182	.01193	.01178
1465000.00 |	.01062	.01095	.01098	.01069	.01046	.01057	.01091	.01120	.01125

Y-COORD | (METERS) |	X-COORD (METERS) 79800.00	79850.00	79900.00	79950.00	80000.00
1467000.00 |	.01635	.01601	.01565	.01534	.01516
1466950.00 |	.01686	.01648	.01613	.01593	.01587
1466900.00 |	.01738	.01700	.01676	.01669	.01673
1466850.00 |	.01794	.01767	.01758	.01762	.01768
1466800.00 |	.01865	.01855	.01859	.01866	.01869
1466750.00 |	.01960	.01965	.01973	.01979	.01984
1466700.00 |	.02081	.02090	.02099	.02108	.02115
1466650.00 |	.02220	.02232	.02245	.02252	.02243
1466600.00 |	.02380	.02397	.02404	.02385	.02337
1466550.00 |	.02567	.02569	.02537	.02470	.02376
1466500.00 |	.02747	.02697	.02605	.02486	.02355

1466450.00	.02854	.02738	.02592	.02440	.02293
1466400.00	.02853	.02688	.02520	.02362	.02223
1466350.00	.02763	.02586	.02427	.02283	.02162
1466300.00	.02631	.02472	.02340	.02230	.02138
1466250.00	.02508	.02395	.02308	.02236	.02169
1466200.00	.02477	.02415	.02361	.02309	.02251
1466150.00	.02570	.02522	.02468	.02409	.02339
1466100.00	.02688	.02618	.02543	.02465	.02382
1466050.00	.02740	.02661	.02582	.02503	.02424
1466000.00	.02828	.02754	.02677	.02600	.02521
1465950.00	.02965	.02881	.02794	.02707	.02619
1465900.00	.02997	.02907	.02815	.02723	.02631
1465850.00	.02872	.02798	.02719	.02639	.02556
1465800.00	.02685	.02623	.02559	.02494	.02425
1465750.00	.02648	.02549	.02462	.02385	.02311
1465700.00	.02804	.02661	.02529	.02411	.02303
1465650.00	.02893	.02784	.02663	.02537	.02406
1465600.00	.02808	.02745	.02673	.02587	.02484
1465550.00	.02702	.02638	.02577	.02514	.02445
1465500.00	.02627	.02561	.02491	.02418	.02353
1465450.00	.02523	.02487	.02427	.02354	.02281
1465400.00	.02352	.02364	.02339	.02291	.02229
1465350.00	.02128	.02179	.02199	.02190	.02159
1465300.00	.01881	.01959	.02013	.02042	.02047
1465250.00	.01639	.01731	.01806	.01861	.01896
1465200.00	.01439	.01517	.01598	.01668	.01723
1465150.00	.01298	.01342	.01408	.01481	.01546
1465100.00	.01210	.01219	.01256	.01312	.01376
1465050.00	.01153	.01140	.01148	.01178	.01226
1465000.00	.01109	.01087	.01076	.01083	.01109

THE ANNUAL (8760 HRS) AVERAGE CONCENTRATION
VALUES FOR SOURCE GROUP: ALL
INCLUDING SOURCE(S): FFF5845 , FFF5946 , FFF6047 , FSC1953 , FSC2155 , FSC2256 , FEF5437 ,
FEF5640 , FSC2783 , FEF2094 , FEF1774 , FSC3199 , FSC32100,

***** NETWORK ID: CART1 ; NETWORK TYPE: GRIDCART *****

**** CONC OF BENZENE IN MICROGRAMS/M**3****

Y-COORD (METERS)	78000.00	78050.00	78100.00	78150.00	78200.00	78250.00	78300.00	78350.00	78400.00
1467000.00	.24588	.24558	.24475	.24642	.25220	.26216	.27498	.28853	.30446
1466950.00	.25530	.25703	.25640	.25572	.25809	.26489	.27575	.28904	.30384
1466900.00	.26489	.26769	.26896	.26798	.26751	.27066	.27843	.29004	.30401
1466850.00	.27681	.27865	.28103	.28173	.28036	.28017	.28413	.29275	.30503
1466800.00	.29214	.29215	.29356	.29537	.29536	.29359	.29373	.29846	.30776
1466750.00	.31120	.30939	.30886	.30970	.31077	.30988	.30766	.30816	.31309
1466700.00	.33371	.33082	.32829	.32707	.32716	.32726	.32526	.32196	.32180
1466650.00	.35833	.35615	.35249	.34903	.34689	.34598	.34411	.33966	.33509
1466600.00	.38274	.38363	.38118	.37655	.37180	.36777	.36441	.36002	.35319
1466550.00	.40573	.41046	.41193	.40924	.40281	.39508	.38848	.38255	.37500
1466500.00	.42759	.43545	.44132	.44333	.43932	.43018	.41913	.40912	.39961
1466450.00	.44651	.45829	.46805	.47455	.47646	.47155	.45944	.44366	.42858
1466400.00	.46014	.47650	.49073	.50164	.50906	.51149	.50581	.49001	.46780
1466350.00	.47040	.48972	.50776	.52360	.53617	.54449	.54707	.54053	.52094
1466300.00	.47807	.49961	.52041	.54014	.55764	.57129	.57957	.58123	.57304
1466250.00	.47790	.50285	.52732	.55090	.57285	.59186	.60618	.61352	.61173
1466200.00	.46737	.49409	.52168	.54957	.57671	.60156	.62277	.63778	.64333
1466150.00	.44988	.47622	.50395	.53285	.56235	.59155	.61905	.64225	.65768
1466100.00	.42463	.44981	.47644	.50435	.53307	.56218	.59072	.61705	.63868

1466050.00	.39609	.41830	.44179	.46646	.49192	.51792	.54360	.56767	.58817
1466000.00	.37710	.39649	.41669	.43752	.45846	.47931	.49909	.51661	.53019
1465950.00	.36486	.38264	.40099	.41968	.43819	.45622	.47275	.48653	.49581
1465900.00	.34304	.35715	.37117	.38475	.39724	.40816	.41636	.42051	.41888
1465850.00	.29873	.30631	.31290	.31813	.32143	.32247	.32058	.31522	.30601
1465800.00	.24394	.24721	.24987	.25192	.25333	.25431	.25485	.25495	.25444
1465750.00	.20444	.20861	.21319	.21823	.22374	.22975	.23640	.24409	.25370
1465700.00	.18669	.19329	.20059	.20888	.21863	.23058	.24556	.26361	.28274
1465650.00	.18162	.19095	.20214	.21585	.23242	.25134	.27066	.28672	.29615
1465600.00	.18708	.20120	.21737	.23508	.25254	.26720	.27715	.28242	.28401
1465550.00	.20165	.21772	.23280	.24546	.25461	.26060	.26469	.26712	.26644
1465500.00	.21296	.22397	.23210	.23778	.24246	.24682	.24987	.25081	.25310
1465450.00	.21054	.21581	.22056	.22528	.22990	.23319	.23551	.24088	.25364
1465400.00	.19984	.20437	.20952	.21421	.21754	.22102	.22857	.24272	.25928
1465350.00	.19023	.19512	.19941	.20304	.20758	.21648	.23099	.24692	.25779
1465300.00	.18224	.18596	.18949	.19493	.20485	.21909	.23398	.24435	.25047
1465250.00	.17389	.17747	.18336	.19340	.20715	.22110	.23079	.23663	.24500
1465200.00	.16678	.17300	.18290	.19563	.20819	.21732	.22306	.23013	.24453
1465150.00	.16366	.17325	.18496	.19623	.20444	.20966	.21585	.22786	.24769
1465100.00	.16438	.17509	.18520	.19260	.19731	.20252	.21230	.22883	.25206
1465050.00	.16597	.17505	.18172	.18598	.19042	.19845	.21207	.23168	.25573
1465000.00	.16570	.17173	.17559	.17940	.18607	.19736	.21384	.23502	.25747

Y-COORD (METERS)	X-COORD (METERS) 78450.00	78500.00	78550.00	78600.00	78650.00	78700.00	78750.00	78800.00	78850.00
1467000.00	.32737	.35234	.37108	.38337	.39999	.42593	.44683	.45453	.45849
1466950.00	.32469	.35232	.37668	.39225	.40728	.43327	.45896	.47053	.47501

1466900.00 |	.32214	.34955	.37948	.40055	.41544	.43963	.46933	.48553	.49091
1466850.00 |	.32076	.34514	.37837	.40612	.42273	.44407	.47671	.49891	.50638
1466800.00 |	.32085	.34010	.37202	.40686	.42907	.44806	.48160	.51063	.52144
1466750.00 |	.32195	.33611	.36288	.40204	.43296	.45195	.48380	.51976	.53552
1466700.00 |	.32613	.33502	.35403	.39141	.43186	.45517	.48328	.52486	.54750
1466650.00 |	.33442	.33793	.34839	.37714	.42311	.45602	.48067	.52520	.55665
1466600.00 |	.34725	.34541	.34794	.36389	.40621	.45115	.47632	.51928	.56090
1466550.00 |	.36517	.35733	.35348	.35645	.38439	.43625	.46914	.50647	.55788
1466500.00 |	.38783	.37424	.36383	.35711	.36497	.40952	.45556	.48698	.54466
1466450.00 |	.41405	.39670	.37838	.36416	.35503	.37599	.42948	.46137	.51809
1466400.00 |	.44535	.42352	.39871	.37452	.35505	.34756	.38711	.42826	.47594
1466350.00 |	.49008	.45670	.42438	.38981	.35852	.33289	.33621	.38182	.41864
1466300.00 |	.54909	.50755	.45869	.41146	.36464	.32538	.29575	.31666	.34993
1466250.00 |	.59869	.56872	.51503	.44577	.37823	.31753	.27094	.24595	.27285
1466200.00 |	.63570	.61236	.57085	.50341	.41085	.31868	.24609	.19670	.18594
1466150.00 |	.66088	.64625	.60831	.54582	.45971	.34714	.23264	.15576	.11410
1466100.00 |	.65168	.65024	.62686	.57372	.48682	.37562	.25020	.13274	.07579
1466050.00 |	.60218	.60551	.59239	.55544	.48715	.38250	.25482	.14466	.05701
1466000.00 |	.53747	.53528	.51961	.48583	.42967	.34543	.24233	.14094	.06264
1465950.00 |	.49820	.49057	.46920	.43028	.37136	.28986	.19838	.11243	.05268
1465900.00 |	.40938	.38971	.35779	.31276	.25626	.19117	.12724	.07312	.03440
1465850.00 |	.29277	.27551	.25425	.22893	.20036	.17066	.13935	.09355	.04242
1465800.00 |	.25306	.25088	.24880	.24715	.24028	.21504	.16076	.09695	.06149
1465750.00 |	.26605	.27983	.28878	.28349	.25808	.21143	.16166	.12627	.11635
1465700.00 |	.29794	.30345	.29659	.27587	.24390	.21679	.19444	.18892	.18051
1465650.00 |	.29811	.29276	.27886	.26242	.25402	.24394	.24250	.25242	.23695
1465600.00 |	.28119	.27379	.26969	.27385	.27328	.27510	.29522	.29731	.27870

1465550.00	.26448	.26891	.28038	.28590	.28994	.31299	.33340	.32290	.30945
1465500.00	.26287	.27802	.28695	.29230	.31385	.34451	.35075	.33612	.33070
1465450.00	.27020	.28074	.28677	.30515	.33815	.36005	.35318	.34197	.34430
1465400.00	.27033	.27664	.29172	.32234	.35323	.35997	.34832	.34287	.35204
1465350.00	.26406	.27634	.30265	.33600	.35547	.35032	.34054	.34021	.35533
1465300.00	.26054	.28225	.31386	.34119	.34689	.33695	.33155	.33511	.35513
1465250.00	.26272	.29063	.32070	.33672	.33225	.32308	.32193	.32849	.35216
1465200.00	.26826	.29750	.32051	.32478	.31582	.30993	.31192	.32098	.34697
1465150.00	.27417	.30017	.31302	.30880	.29999	.29779	.30183	.31305	.34008
1465100.00	.27814	.29713	.30007	.29193	.28556	.28632	.29175	.30492	.33189
1465050.00	.27795	.28837	.28440	.27595	.27268	.27545	.28190	.29663	.32269
1465000.00	.27302	.27514	.26796	.26150	.26110	.26506	.27242	.28829	.31284

Y-COORD	X-COORD (METERS)								
(METERS)	78900.00	78950.00	79000.00	79050.00	79100.00	79150.00	79200.00	79250.00	79300.00
1467000.00	.46755	.47313	.47014	.46464	.46554	.47776	.48830	.47999	.46106
1466950.00	.48406	.49056	.48758	.48139	.48307	.49696	.50521	.49246	.47434
1466900.00	.49967	.50702	.50403	.49712	.50006	.51577	.52105	.50508	.48996
1466850.00	.51496	.52321	.52016	.51236	.51680	.53354	.53449	.51694	.50705
1466800.00	.52997	.53908	.53589	.52719	.53360	.55059	.54671	.53002	.52609
1466750.00	.54424	.55412	.55066	.54119	.55012	.56623	.55790	.54510	.54685
1466700.00	.55708	.56771	.56389	.55367	.56554	.57940	.56840	.56239	.56810
1466650.00	.56800	.57922	.57490	.56435	.57943	.58981	.57920	.58154	.58741
1466600.00	.57555	.58724	.58230	.57196	.59020	.59662	.59093	.60095	.60231
1466550.00	.57805	.59015	.58443	.57517	.59607	.59961	.60339	.61684	.60986
1466500.00	.57318	.58573	.57914	.57215	.59479	.59896	.61457	.62388	.61064
1466450.00	.55787	.57111	.56371	.56050	.58393	.59468	.61893	.61774	.61032

1466400.00	.52829	.54290	.53494	.53717	.56138	.58495	.60738	.60161	.61302
1466350.00	.48032	.49750	.48968	.49874	.52594	.56277	.57428	.58602	.61588
1466300.00	.41103	.43243	.42601	.44221	.47685	.51563	.53065	.57399	.62299
1466250.00	.32208	.34860	.34544	.36716	.41061	.44220	.49412	.56662	.64033
1466200.00	.21990	.24784	.25005	.27393	.31869	.37356	.46826	.56716	.66201
1466150.00	.13052	.15614	.16331	.18126	.22401	.32707	.45007	.56087	.63852
1466100.00	.06538	.08837	.09713	.10895	.18247	.29573	.40686	.49177	.52944
1466050.00	.03085	.05195	.05821	.08936	.16119	.23334	.29888	.36212	.43069
1466000.00	.02455	.02450	.03598	.07759	.09966	.14813	.22140	.32208	.42264
1465950.00	.03439	.00926	.00469	.04116	.07794	.12427	.20784	.31973	.43368
1465900.00	.01341	.00782	.01349	.05367	.07977	.12108	.19649	.29964	.40718
1465850.00	.02200	.03053	.03014	.06074	.10533	.15222	.23619	.35005	.44627
1465800.00	.05146	.07105	.07535	.09019	.11540	.17678	.27571	.37528	.47544
1465750.00	.10495	.12878	.13555	.12676	.17052	.20737	.28244	.39630	.49123
1465700.00	.16643	.19926	.20090	.18617	.22124	.26686	.30085	.36831	.47639
1465650.00	.22990	.27118	.26204	.24827	.25905	.29831	.34419	.36647	.42196
1465600.00	.28408	.32888	.30952	.29736	.28343	.32528	.35365	.39292	.40364
1465550.00	.32811	.37111	.34447	.33120	.30568	.33710	.35808	.38948	.41553
1465500.00	.36073	.39850	.36773	.35122	.32643	.33414	.36446	.37392	.40615
1465450.00	.38229	.41326	.38086	.36073	.34182	.32840	.35987	.36693	.38068
1465400.00	.39420	.41822	.38589	.36290	.34982	.32545	.34490	.36206	.36073
1465350.00	.39830	.41599	.38480	.36007	.35086	.32453	.32764	.35038	.34984
1465300.00	.39641	.40875	.37929	.35387	.34652	.32333	.31318	.33229	.34028
1465250.00	.39017	.39816	.37070	.34543	.33855	.32028	.30242	.31254	.32666
1465200.00	.38087	.38544	.36006	.33554	.32836	.31491	.29424	.29473	.30927
1465150.00	.36955	.37150	.34817	.32481	.31704	.30747	.28735	.28017	.29074
1465100.00	.35721	.35721	.33582	.31368	.30523	.29844	.28067	.26843	.27338

1465050.00	.34405	.34258	.32300	.30225	.29327	.28827	.27358	.25882	.25829
1465000.00	.33065	.32811	.31018	.29085	.28149	.27755	.26592	.25059	.24553

Y-COORD (METERS)	X-COORD (METERS) 79350.00	79400.00	79450.00	79500.00	79550.00	79600.00	79650.00	79700.00	79750.00
1467000.00	.45038	.44886	.44708	.44109	.43263	.42318	.41479	.40865	.40251
1466950.00	.46772	.46739	.46384	.45579	.44572	.43586	.42873	.42263	.41524
1466900.00	.48723	.48664	.48053	.47026	.45899	.45030	.44398	.43679	.42791
1466850.00	.50793	.50599	.49680	.48444	.47368	.46665	.45973	.45082	.44154
1466800.00	.52830	.52340	.51174	.49930	.49074	.48404	.47534	.46557	.45853
1466750.00	.54793	.53879	.52508	.51522	.50944	.50144	.49138	.48367	.48106
1466700.00	.56526	.55185	.53926	.53315	.52721	.51844	.51069	.50790	.50948
1466650.00	.57858	.56374	.55602	.55175	.54435	.53744	.53604	.53891	.54286
1466600.00	.58780	.57699	.57448	.56949	.56362	.56330	.56828	.57522	.58199
1466550.00	.59582	.59329	.59185	.58838	.59013	.59751	.60725	.61777	.62689
1466500.00	.60635	.60969	.60995	.61465	.62569	.63977	.65439	.66590	.66801
1466450.00	.61860	.62547	.63534	.65167	.67107	.69139	.70534	.70527	.68971
1466400.00	.62983	.64791	.67214	.69963	.72657	.74242	.73909	.71739	.68441
1466350.00	.64656	.68229	.72106	.75657	.77363	.76524	.73739	.69968	.65862
1466300.00	.67498	.72903	.77449	.79193	.77894	.74643	.70513	.66262	.62319
1466250.00	.71376	.77002	.78822	.77303	.73854	.69662	.65577	.62086	.59357
1466200.00	.72926	.75138	.73807	.70572	.66955	.63914	.61725	.60231	.59164
1466150.00	.66852	.66227	.64341	.62906	.62328	.62282	.62333	.62193	.61751
1466100.00	.54687	.56784	.59497	.62121	.64077	.65159	.65414	.64991	.64068
1466050.00	.50387	.56777	.61543	.64667	.66420	.67118	.67045	.66419	.65408
1466000.00	.50955	.57920	.63060	.66540	.68627	.69609	.69743	.69246	.68292
1465950.00	.53139	.60860	.66420	.70053	.72108	.72941	.72861	.72118	.70907

1465900.00	.50324	.58173	.64012	.67972	.70346	.71459	.71613	.71060	.69998
1465850.00	.51637	.56632	.60307	.63015	.64890	.66009	.66458	.66339	.65758
1465800.00	.56720	.63321	.66742	.67692	.67243	.66199	.64979	.63741	.62514
1465750.00	.56721	.62872	.67714	.70884	.72070	.71467	.69635	.67179	.64567
1465700.00	.56320	.62315	.66249	.68795	.70480	.71364	.71280	.70171	.68214
1465650.00	.51565	.59269	.64307	.67210	.68517	.68883	.68803	.68421	.67673
1465600.00	.44640	.52396	.59157	.63611	.66107	.67026	.66837	.66084	.65142
1465550.00	.41815	.45022	.51294	.57173	.61222	.63576	.64502	.64309	.63372
1465500.00	.41942	.41734	.44123	.49139	.54201	.57912	.60229	.61308	.61316
1465450.00	.40765	.41153	.40716	.42500	.46497	.50829	.54229	.56492	.57717
1465400.00	.37978	.39891	.39689	.39170	.40516	.43716	.47392	.50466	.52652
1465350.00	.35239	.37239	.38409	.37884	.37378	.38413	.40965	.44066	.46824
1465300.00	.33421	.34273	.36036	.36630	.35965	.35486	.36285	.38334	.40923
1465250.00	.32259	.31959	.33176	.34546	.34725	.34014	.33591	.34204	.35808
1465200.00	.31193	.30436	.30634	.31917	.32895	.32808	.32104	.31702	.32159
1465150.00	.29869	.29333	.28783	.29379	.30556	.31186	.30910	.30237	.29899
1465100.00	.28308	.28274	.27507	.27347	.28138	.29107	.29469	.29115	.28516
1465050.00	.26676	.27068	.26497	.25863	.26042	.26895	.27672	.27851	.27464
1465000.00	.25107	.25695	.25504	.24783	.24444	.24875	.25699	.26293	.26341

Y-COORD (METERS)	X-COORD (METERS) 79800.00	79850.00	79900.00	79950.00	80000.00
1467000.00	.39505	.38666	.37926	.37483	.37356
1466950.00	.40655	.39849	.39346	.39193	.39264
1466900.00	.41921	.41354	.41173	.41249	.41382
1466850.00	.43519	.43310	.43393	.43549	.43655
1466800.00	.45617	.45714	.45903	.46057	.46210
1466750.00	.48226	.48462	.48682	.48916	.49121
1466700.00	.51249	.51560	.51892	.52135	.52062
1466650.00	.54721	.55169	.55431	.55224	.54402
1466600.00	.58778	.59020	.58595	.57406	.55577
1466550.00	.62894	.62134	.60465	.58127	.55409
1466500.00	.65759	.63497	.60585	.57394	.54200

1466450.00 |	.66264	.62881	.59241	.55759	.52588
1466400.00 |	.64667	.60868	.57198	.53908	.51058
1466350.00 |	.61894	.58304	.55138	.52370	.50086
1466300.00 |	.58918	.56126	.53881	.51902	.50244
1466250.00 |	.57259	.55627	.54278	.52970	.51682
1466200.00 |	.58248	.57337	.56353	.55209	.53839
1466150.00 |	.60978	.59902	.58598	.57113	.55363
1466100.00 |	.62826	.61338	.59721	.58039	.56179
1466050.00 |	.64158	.62718	.61171	.59563	.57787
1466000.00 |	.67037	.65548	.63918	.62202	.60313
1465950.00 |	.69399	.67670	.65813	.63889	.61815
1465900.00 |	.68610	.66970	.65181	.63308	.61275
1465850.00 |	.64841	.63639	.62244	.60716	.58973
1465800.00 |	.61302	.60046	.58750	.57409	.55879
1465750.00 |	.62051	.59734	.57649	.55760	.53887
1465700.00 |	.65682	.62866	.60022	.57268	.54621
1465650.00 |	.66423	.64653	.62450	.59875	.57111
1465600.00 |	.64137	.63039	.61751	.60067	.58119
1465550.00 |	.62092	.60755	.59431	.58054	.56684
1465500.00 |	.60517	.59228	.57646	.56056	.54609
1465450.00 |	.57997	.57442	.56226	.54722	.53153
1465400.00 |	.53991	.54412	.54088	.53219	.51986
1465350.00 |	.48851	.50141	.50775	.50785	.50261
1465300.00 |	.43307	.45180	.46514	.47321	.47593
1465250.00 |	.37955	.40083	.41846	.43176	.44083
1465200.00 |	.33470	.35297	.37193	.38836	.40129
1465150.00 |	.30278	.31363	.32920	.34603	.36122
1465100.00 |	.28239	.28556	.29460	.30789	.32280
1465050.00 |	.26937	.26711	.26979	.27736	.28874
1465000.00 |	.25949	.25487	.25303	.25532	.26170

***** THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS *****

**** CONC OF BENZENE IN MICROGRAMS/M**3 ****

GROUP ID	AVERAGE CONC	RECEPTOR (XR, YR, ZELEV, ZFLAG)	NETWORK OF TYPE	GRID-ID
LINE1	1ST HIGHEST VALUE IS .65794	AT (79500.00, 1466300.00, .00, .00)	GC	CART1
	2ND HIGHEST VALUE IS .65302	AT (79450.00, 1466250.00, .00, .00)	GC	CART1
LINE2	1ST HIGHEST VALUE IS .10044	AT (79550.00, 1466300.00, .00, .00)	GC	CART1
	2ND HIGHEST VALUE IS .09986	AT (79500.00, 1466250.00, .00, .00)	GC	CART1
LINE3	1ST HIGHEST VALUE IS .03770	AT (79400.00, 1466200.00, .00, .00)	GC	CART1
	2ND HIGHEST VALUE IS .03764	AT (79350.00, 1466150.00, .00, .00)	GC	CART1
LINE12	1ST HIGHEST VALUE IS .75701	AT (79500.00, 1466300.00, .00, .00)	GC	CART1
	2ND HIGHEST VALUE IS .75159	AT (79450.00, 1466250.00, .00, .00)	GC	CART1
LINE23	1ST HIGHEST VALUE IS .13632	AT (79500.00, 1466250.00, .00, .00)	GC	CART1
	2ND HIGHEST VALUE IS .13549	AT (79550.00, 1466300.00, .00, .00)	GC	CART1
LINE13	1ST HIGHEST VALUE IS .69285	AT (79500.00, 1466300.00, .00, .00)	GC	CART1
	2ND HIGHEST VALUE IS .68966	AT (79450.00, 1466250.00, .00, .00)	GC	CART1
ALL	1ST HIGHEST VALUE IS .79193	AT (79500.00, 1466300.00, .00, .00)	GC	CART1
	2ND HIGHEST VALUE IS .78822	AT (79450.00, 1466250.00, .00, .00)	GC	CART1

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

***** THE SUMMARY OF HIGHEST 24-HR RESULTS *****

**** CONC OF BENZENE IN MICROGRAMS/M**3 ****

GROUP ID		AVERAGE CONC	DATE (YYMMDDHH)	RECEPTOR (XR, YR, ZELEV, ZFLAG) NETWORK
LINE1	HIGH	1ST HIGH VALUE IS 9.62033	ON 91051724:	AT (78400.00, 1465650.00, .00, .00)
LINE2	HIGH	1ST HIGH VALUE IS 1.60427	ON 91051724:	AT (78400.00, 1465600.00, .00, .00)
LINE3	HIGH	1ST HIGH VALUE IS .60768	ON 91051724:	AT (78600.00, 1465700.00, .00, .00)
LINE12	HIGH	1ST HIGH VALUE IS 10.95743	ON 91051724:	AT (78400.00, 1465650.00,.00,.00)
LINE23	HIGH	1ST HIGH VALUE IS 2.13750	ON 91051724:	AT (78400.00, 1465600.00, .00,.00)
LINE13	HIGH	1ST HIGH VALUE IS 10.04036	ON 91051724:	AT (78400.00, 1465650.00,.00, .00)
ALL	HIGH	1ST HIGH VALUE IS 11.37746	ON 91051724:	AT (78400.00, 1465650.00, .00,.00)

*** ISCST3 - VERSION 96113 *** *** TRIAL ***
02/21/98
*** *** 10:21:11
PAGE 212

**MODELOPTs: CONC RURAL FLAT DFAULT

*** Message Summary : ISCST3 Model Execution ***

--------- Summary of Total Messages --------

A Total of 0 Fatal Error Message(s)
A Total of 0 Warning Message(s)
A Total of 721 Informational Message(s)

A Total of 721 Calm Hours Identified

******** FATAL ERROR MESSAGES ********
*** NONE ***

******** WARNING MESSAGES ********
*** NONE ***

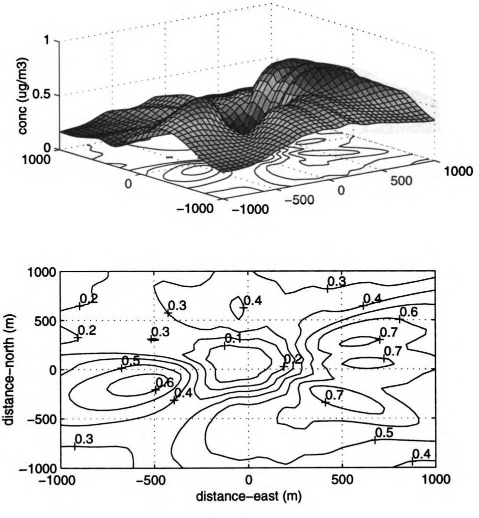
****
*** ISCST3 Finishes Successfully ***
****

APPENDIX F

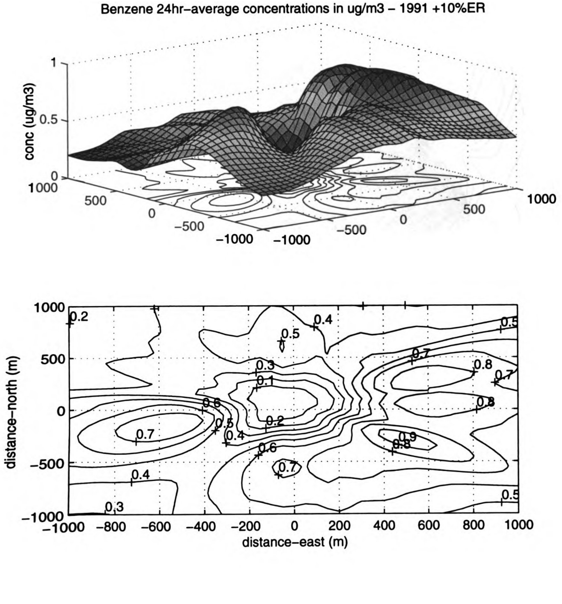
Appendix F

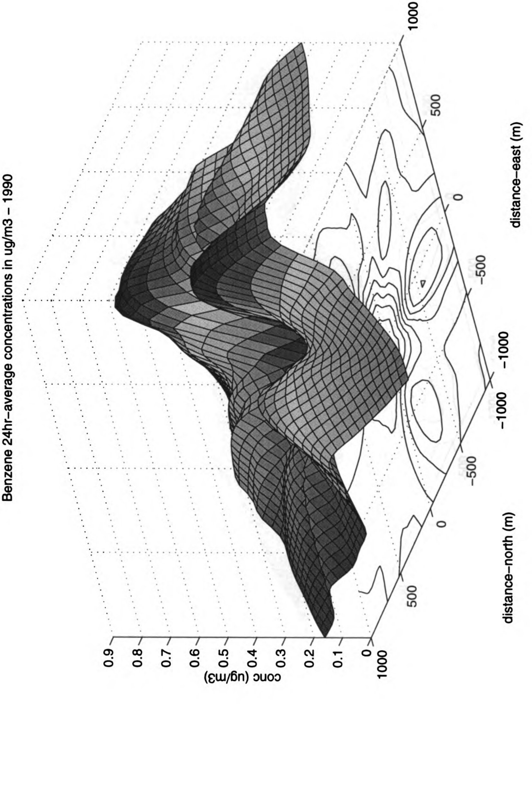
Graphical Results of Dispersion Modeling under Full Production Rates

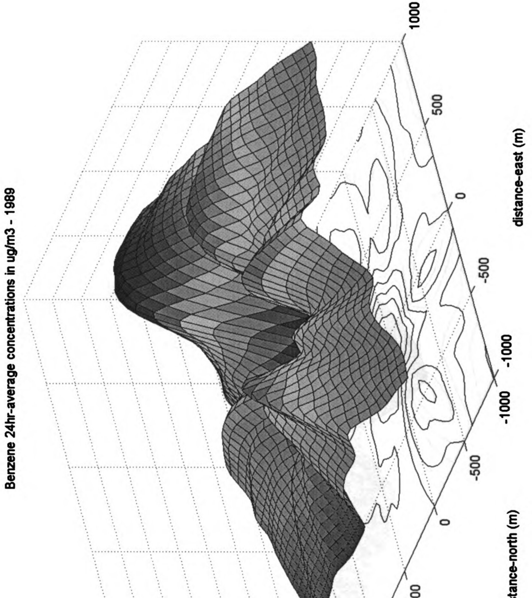
Benzene 24hr–average concentrations in ug/m3 – 1991



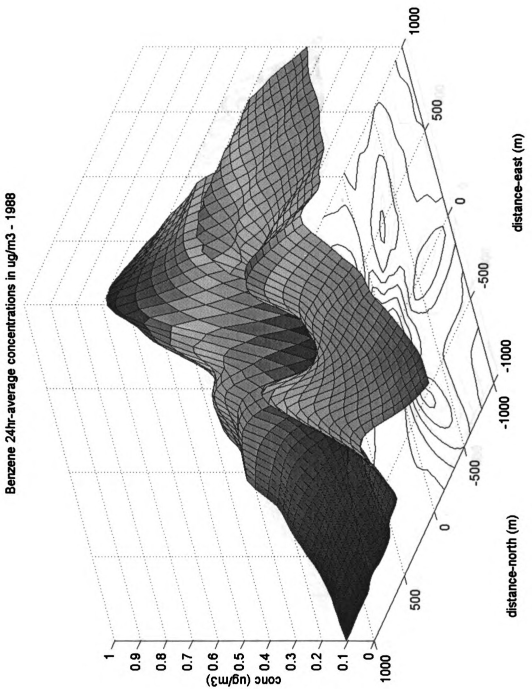
Graphical Results of Sensitivity Analysis to a 10% Increase in Emission Rates

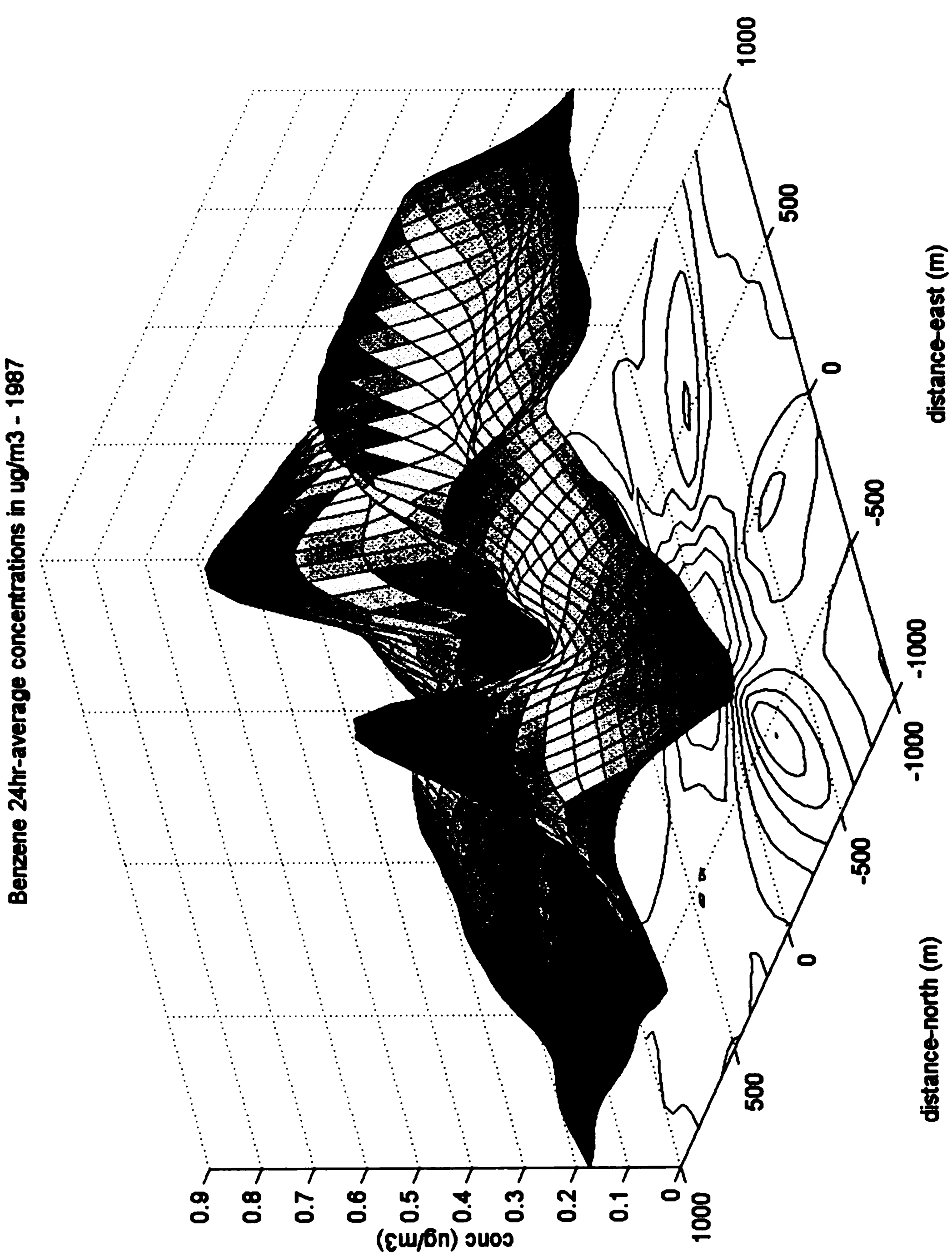



Benzene 24hr–average concentrations in ug/m3 – 1990
conc (ug/m3)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1000
500
0
-500
-1000
distance–north (m)
-1000
-500
0
500
1000
distance–east (m)



Benzene 24hr-average concentrations in ug/m3 - 1989
conc (ug/m3)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1000
500
0
-500
-1000
distance-north (m)
-1000
-500
0
500
1000
distance-east (m)


Benzene 24hr-average concentrations in ug/m3 - 1988
conc (ug/m3)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
distance-north (m)
1000
500
0
-500
-1000
distance-east (m)
-1000
-500
0
500
1000


Benzene 24hr-average concentrations in ug/m3 - 1987
conc (ug/m3)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1000
500
0
-500
-1000
distance-north (m)
-1000
-500
0
500
1000
distance-east (m)

APPENDIX G

Predicted Concentrations - PDF Characteristics Development

Scenario 7AM | **Year 87**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.13904	0.02193	0.00771	0.16097	0.02964	0.14675	0.16868	0.154	0.021
R2	79550	1465700	0.39648	0.06338	0.02206	0.45986	0.08544	0.41854	0.48192	0.439	0.060
R3	79550	1466300	0.38868	0.06096	0.02024	0.44964	0.0812	0.40892	0.46988	0.429	0.057
R4	78000	1465000	0.09957	0.01739	0.00503	0.11696	0.02242	0.1046	0.12199	0.111	0.016
R5	80000	1465000	0.21087	0.03916	0.01106	0.25003	0.05022	0.22193	0.26109	0.236	0.036
R6	80000	1467000	0.13269	0.02341	0.00672	0.1561	0.03013	0.13941	0.16282	0.148	0.021
R7	78000	1467000	0.18926	0.03275	0.00941	0.22201	0.04216	0.19867	0.23142	0.210	0.030

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.87403	0.3896	0.15074	3.26363	0.54034	3.02477	3.41437	3.144	0.382
R2	79550	1465700	3.97896	0.76684	0.22472	4.7458	0.99156	4.20368	4.97052	4.475	0.701
R3	79550	1466300	4.23021	0.60998	0.17532	4.84019	0.7853	4.40553	5.01551	4.623	0.555
R4	78000	1465000	1.43412	0.29105	0.08648	1.72517	0.37753	1.5206	1.81165	1.623	0.267
R5	80000	1465000	2.24929	0.43002	0.11781	2.67931	0.54783	2.3671	2.79712	2.523	0.387
R6	80000	1467000	1.60327	0.30313	0.08764	1.9064	0.39077	1.69091	1.99404	1.799	0.276
R7	78000	1467000	2.14642	0.40184	0.10795	2.54826	0.50979	2.25437	2.65621	2.401	0.360

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.39648	0.06338	0.02206	0.45986	0.08544	0.41854	0.48192	0.439	0.060
2nd Higest	79550	1466300	0.38868	0.06096	0.02024	0.44964	0.0812	0.40892	0.46988	0.429	0.057

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300	4.23021			4.84019		4.40151	5.01149		
	79550	1465700		0.76684	0.22472		0.99008				
Dates			87091424	87091424	87062724	87091424	87062724	87062724	87062724		

Scenario 8 AM — Year 87

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.13831	0.02162	0.00763	0.15993	0.02925	0.14594	0.16756	0.153	0.021
R2	79550	1465700	0.39699	0.06326	0.02208	0.46025	0.08534	0.41907	0.48233	0.440	0.060
R3	79550	1466300	0.35887	0.05799	0.01914	0.41686	0.07713	0.37801	0.436	0.397	0.055
R4	78000	1465000	0.09756	0.01685	0.00486	0.11441	0.02171	0.10242	0.11927	0.108	0.015
R5	80000	1465000	0.20843	0.03867	0.01093	0.2471	0.0496	0.21936	0.25803	0.233	0.035
R6	80000	1467000	0.12692	0.02241	0.00646	0.14933	0.02887	0.13338	0.15579	0.141	0.020
R7	78000	1467000	0.18826	0.03251	0.00939	0.22077	0.0419	0.19765	0.23016	0.209	0.030

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.87403	0.3896	0.15074	3.26363	0.54034	3.02477	3.41437	3.144	0.382
R2	79550	1465700	3.97896	0.76684	0.22324	4.7458	0.99008	4.2022	4.96904	4.474	0.700
R3	79550	1466300	4.22993	0.60997	0.1723	4.8399	0.78227	4.40223	5.0122	4.621	0.553
R4	78000	1465000	1.36795	0.29945	0.07988	1.6674	0.37933	1.44783	1.74728	1.558	0.268
R5	80000	1465000	2.15022	0.40949	0.11259	2.55971	0.52208	2.26281	2.6723	2.411	0.369
R6	80000	1467000	1.73849	0.33431	0.09946	2.0728	0.43377	1.83795	2.17226	1.955	0.307
R7	78000	1467000	2.58227	0.43478	0.12968	3.01705	0.56446	2.71195	3.14673	2.865	0.399

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.39699	0.06326	0.02208	0.46025	0.08534	0.41907	0.48233	0.440	0.060
2nd Higest	79550	1466300	0.35887	0.05799	0.01914	0.41686	0.07713	0.37801	0.436	0.397	0.055

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123
1ST Higest	79550	1466300	4.22993			4.8399		4.40123	5.0112
	79550	1465700		0.76684	0.22324		0.99008		
Dates			87091424	87091424	87080224	87091424	87091424	87091424	87091424

Scenario 9AM Year 91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.12983	0.02004	0.00721	0.14987	0.02725	0.13704	0.15708	0.143	0.019
R2	79550	1465700	0.3893	0.06195	0.02173	0.45125	0.08368	0.41103	0.47298	0.431	0.059
R3	79550	1466300	0.34665	0.05579	0.0185	0.40244	0.07429	0.36515	0.42094	0.384	0.053
R4	78000	1465000	0.0956	0.01663	0.00482	0.11223	0.02145	0.10042	0.11705	0.106	0.015
R5	80000	1465000	0.20363	0.03784	0.01069	0.24147	0.04853	0.21432	0.25216	0.228	0.034
R6	80000	1467000	0.12223	0.02164	0.0063	0.14387	0.02794	0.12853	0.15017	0.136	0.020
R7	78000	1467000	0.19389	0.03326	0.00966	0.22715	0.04292	0.20355	0.23681	0.215	0.030

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.87403	0.3896	0.12943	3.26363	0.51903	3.00346	3.39306	3.134	0.367
R2	79550	1465700	3.97896	0.76684	0.23337	4.7458	1.00021	4.21233	4.97917	4.479	0.707
R3	79550	1466300	4.31445	0.62992	0.17897	4.94437	0.80889	4.49342	5.12334	4.719	0.572
R4	78000	1465000	1.70813	0.29945	0.08655	2.00758	0.386	1.79468	2.09413	1.901	0.273
R5	80000	1465000	2.37528	0.45275	0.12433	2.82803	0.57708	2.49961	2.95236	2.664	0.408
R6	80000	1467000	1.52034	0.28935	0.08744	1.80969	0.37679	1.60778	1.89713	1.709	0.266
R7	78000	1467000	2.58227	0.43478	0.12968	3.01705	0.56446	2.71195	3.14673	2.865	0.399

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.3893	0.06195	0.02173	0.45125	0.08368	0.41103	0.47298	0.431	0.059
2nd Higest	79550	1466300	0.34665	0.05579	0.0185	0.40244	0.07429	0.36515	0.42094	0.384	0.053

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300	4.31445			4.94437		4.49342	5.12334		
	79550	1465700		0.76684	0.23337		0.99008				
Dates			87091424	87091424	87062724	87091424	87062724	87091424	87091424		

Scenario10 AM Year87

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.13307	0.02053	0.00743	0.1536	0.02796	0.16103	0.18156	0.157	0.034
R2	79550	1465700	0.37747	0.05963	0.02111	0.4371	0.08074	0.39858	0.45821	0.418	0.057
R3	79550	1466300	0.32961	0.0518	0.01748	0.38141	0.06928	0.34709	0.39889	0.364	0.049
R4	78000	1465000	0.09099	0.01611	0.00466	0.1071	0.02077	0.09565	0.11176	0.101	0.015
R5	80000	1465000	0.20349	0.03766	0.01068	0.24115	0.04834	0.21417	0.25183	0.228	0.034
R6	80000	1467000	0.121	0.02145	0.00634	0.14245	0.02779	0.12734	0.14879	0.135	0.020
R7	78000	1467000	0.19391	0.03307	0.00965	0.22698	0.04272	0.20356	0.23663	0.215	0.030

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.87403	0.3896	0.12943	3.26363	0.51903	3.39306	3.78266	1.958	2.581
R2	79550	1465700	3.1506	0.64154	0.20181	3.79214	0.84335	3.99395	4.63549	2.506	3.011
R3	79550	1466300	4.31629	0.63212	0.1803	4.94841	0.81242	5.12871	5.76083	3.045	3.840
R4	78000	1465000	1.36795	0.29945	0.07988	1.6674	0.37933	1.74728	2.04673	1.069	1.383
R5	80000	1465000	2.3478	0.44809	0.12288	2.79589	0.57097	2.91877	3.36686	1.785	2.237
R6	80000	1467000	1.81498	0.28527	0.10347	2.10025	0.38874	2.20372	2.48899	1.305	1.674
R7	78000	1467000	2.5812	0.43458	0.12964	3.01578	0.56422	3.14542	3.58	1.887	2.394

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.37747	0.05963	0.02111	0.4371	0.08074	0.39858	0.45821	0.418	0.057
2nd Higest	79550	1466300	0.32961	0.0518	0.01748	0.38141	0.06928	0.34709	0.39889	0.364	0.049

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1ST Higest	79550	1466300	4.31629			4.9484		4.49658	5.1287	4.722	0.574
	79550	1465700		0.64154	0.20181		0.84335				
Dates			87091424	87091424	87080224	87091424	87080224	87091424	87091424		

Scenario11 AM Year87

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.13429	0.02017	0.00734	0.15446	0.02751	0.1618	0.18197	0.158	0.034
R2	79550	1465700	0.36234	0.05636	0.02019	0.4187	0.07655	0.43889	0.49525	0.429	0.094
R3	79550	1466300	0.31449	0.04765	0.01624	0.36214	0.06389	0.37838	0.42603	0.370	0.079
R4	78000	1465000	0.08944	0.01555	0.00451	0.10499	0.02006	0.1095	0.12505	0.107	0.025
R5	80000	1465000	0.20332	0.03746	0.01067	0.24078	0.04813	0.25145	0.28891	0.246	0.061
R6	80000	1467000	0.11792	0.0206	0.0061	0.13852	0.0267	0.14462	0.16522	0.142	0.033
R7	78000	1467000	0.18928	0.03225	0.00944	0.22153	0.04169	0.23097	0.26322	0.226	0.052

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.87403	0.3267	0.10561	3.20073	0.43231	3.30634	3.63304	3.254	0.537
R2	79550	1465700	3.20311	0.56425	0.18802	3.76736	0.75227	3.95538	4.51963	3.861	0.931
R3	79550	1466300	3.70046	0.61723	0.17258	4.31769	0.78981	4.49027	5.1075	4.404	0.995
R4	78000	1465000	1.36795	0.29945	0.07988	1.6674	0.37933	1.74728	2.04673	1.707	0.480
R5	80000	1465000	2.08558	0.39621	0.10918	2.48179	0.50539	2.59097	2.98718	2.536	0.638
R6	80000	1467000	1.49651	0.28526	0.08261	1.78177	0.36787	1.86438	2.14964	1.823	0.462
R7	78000	1467000	2.57987	0.43437	0.12956	3.01424	0.56393	3.1438	3.57817	3.079	0.706

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.36234	0.05636	0.02019	0.4187	0.07655	0.43889	0.49525	0.429	0.094
2nd Higest	79550	1466300	0.31449	0.04765	0.01624	0.36214	0.06389	0.37838	0.42603	0.370	0.079

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300	3.70046	0.61723		4.05166	0.78981	3.84075	4.19196		
	79550	1465700			0.18802						
Dates			87102824	87050924	87062724	87102824	87050924	87102824	87102824		

Scenario 12PM **Year 87**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.12349	0.01876	0.00696	0.14225	0.02572	0.14921	0.16797	0.146	0.031
R2	79550	1465700	0.37389	0.05709	0.02067	0.43098	0.07776	0.45165	0.50874	0.441	0.095
R3	79550	1466300	0.30202	0.04436	0.01519	0.34638	0.05955	0.36157	0.40593	0.354	0.073
R4	78000	1465000	0.09009	0.01543	0.00447	0.10552	0.0199	0.10999	0.12542	0.108	0.025
R5	80000	1465000	0.19327	0.03545	0.01014	0.22872	0.04559	0.23886	0.27431	0.234	0.057
R6	80000	1467000	0.12606	0.02199	0.0066	0.14805	0.02859	0.15465	0.17664	0.151	0.036
R7	78000	1467000	0.19146	0.03252	0.00955	0.22398	0.04207	0.23353	0.26605	0.229	0.053

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.70418	0.30663	0.1147	3.01081	0.42133	3.12551	3.43214	3.068	0.515
R2	79550	1465700	3.68246	0.54684	0.20397	4.2293	0.75081	4.43327	4.98011	4.331	0.918
R3	79550	1466300	3.39774	0.54511	0.15994	3.94285	0.70505	4.10279	4.6479	4.023	0.884
R4	78000	1465000	1.36065	0.2961	0.07876	1.65675	0.37486	1.73551	2.03161	1.696	0.474
R5	80000	1465000	2.12005	0.37734	0.11048	2.49739	0.48782	2.60787	2.98521	2.553	0.612
R6	80000	1467000	2.00453	0.28505	0.11179	2.28958	0.39684	2.40137	2.68642	2.345	0.482
R7	78000	1467000	2.57987	0.43437	0.12956	3.01424	0.56393	3.1438	3.57817	3.079	0.706

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.37389	0.05709	0.02067	0.43098	0.07776	0.45165	0.50874	0.441	0.095
2nd Higest	79550	1466300	0.30202	0.04436	0.01519	0.34638	0.05955	0.36157	0.40593	0.354	0.073

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300									
	79550	1465700	3.68246	0.54684	0.20397	4.18871	0.73486	3.88643	4.39268		
Dates			87011224	87062724	87011224	87011224	87062724	87011224	87011224		

Scenario 1PM Year 87

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.11436	0.01727	0.00652	0.13163	0.02379	0.13815	0.15542	0.135	0.029
R2	79550	1465700	0.35985	0.05442	0.01986	0.41427	0.07428	0.43413	0.48855	0.424	0.091
R3	79550	1466300	0.29698	0.04267	0.01472	0.33965	0.05739	0.35437	0.39704	0.347	0.071
R4	78000	1465000	0.08482	0.01456	0.00427	0.09938	0.01883	0.10365	0.11821	0.102	0.024
R5	80000	1465000	0.18656	0.03427	0.00979	0.22083	0.04406	0.23062	0.26489	0.226	0.055
R6	80000	1467000	0.13192	0.02297	0.00693	0.15489	0.0299	0.16182	0.18479	0.158	0.037
R7	78000	1467000	0.18252	0.03063	0.00905	0.21315	0.03968	0.2222	0.25283	0.218	0.050

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.70414	0.30663	0.11602	3.01077	0.42265	3.12679	3.43342	3.069	0.516
R2	79550	1465700	3.99033	0.55005	0.21712	4.54038	0.76717	4.7575	5.30755	4.649	0.931
R3	79550	1466300	3.39774	0.5411	0.15488	3.93884	0.69598	4.09372	4.63482	4.016	0.875
R4	78000	1465000	1.36088	0.29625	0.07882	1.65713	0.37507	1.73595	2.0322	1.697	0.475
R5	80000	1465000	2.32526	0.41642	0.12129	2.74168	0.53771	2.86297	3.27939	2.802	0.675
R6	80000	1467000	2.00453	0.29427	0.11179	2.2988	0.40606	2.41059	2.70486	2.355	0.495
R7	78000	1467000	2.46856	0.41404	0.12407	2.8826	0.53811	3.00667	3.42071	2.945	0.673

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.35985	0.05442	0.01986	0.41427	0.07428	0.43413	0.48855	0.424	0.091
2nd Higest	79550	1466300	0.29698	0.04267	0.01472	0.33965	0.05739	0.35437	0.39704	0.347	0.071

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	3.99033	0.55005	0.21712	4.54038	0.76717	4.20745	4.7575	4.374	0.542
Dates			87011224								

Scenario 2PM **Year87**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.10901	0.01578	0.00607	0.12479	0.02185	0.13086	0.14664	0.128	0.027
R2	79550	1465700	0.36181	0.05385	0.01992	0.41566	0.07377	0.43558	0.48943	0.426	0.090
R3	79550	1466300	0.29345	0.04192	0.01475	0.33537	0.05667	0.35012	0.39204	0.343	0.070
R4	78000	1465000	0.08986	0.01523	0.00448	0.10509	0.01971	0.10957	0.1248	0.107	0.025
R5	80000	1465000	0.18609	0.03405	0.00976	0.22014	0.04381	0.2299	0.26395	0.225	0.055
R6	80000	1467000	0.1406	0.02439	0.00744	0.16499	0.03183	0.17243	0.19682	0.169	0.040
R7	78000	1467000	0.18339	0.03059	0.00909	0.21398	0.03968	0.22307	0.25366	0.219	0.050

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.70414	0.30663	0.11602	3.01077	0.42265	3.12679	3.43342	3.069	0.516
R2	79550	1465700	4.28434	0.58087	0.22944	4.86521	0.81031	5.09465	5.67552	4.980	0.984
R3	79550	1466300	3.39774	0.55586	0.18523	3.9536	0.74109	4.13883	4.69469	4.046	0.917
R4	78000	1465000	1.48773	0.32391	0.08706	1.81164	0.41097	1.8987	2.22261	1.855	0.520
R5	80000	1465000	2.77588	0.49341	0.14465	3.26929	0.63806	3.41394	3.90735	3.342	0.800
R6	80000	1467000	2.00453	0.29427	0.11179	2.2988	0.40606	2.41059	2.70486	2.355	0.495
R7	78000	1467000	2.42158	0.40542	0.12174	2.827	0.52716	2.94874	3.35416	2.888	0.659

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.36181	0.05385	0.01992	0.41566	0.07377	0.43558	0.48943	0.426	0.090
2nd Higest	79550	1466300	0.29345	0.04192	0.01475	0.33537	0.05667	0.35012	0.39204	0.343	0.070

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	4.28434	0.58087	0.22944	4.86521	0.81032	4.51378	5.09466	4.690	0.573
Dates			87011224								

Scenario 3PM **Year 87**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.10441	0.01467	0.00576	0.11908	0.02043	0.12484	0.13951	0.122	0.025
R2	79550	1465700	0.35453	0.05142	0.01933	0.40595	0.07075	0.42528	0.4767	0.416	0.086
R3	79550	1466300	0.31157	0.04367	0.0156	0.35524	0.05927	0.37084	0.41451	0.363	0.073
R4	78000	1465000	0.09515	0.01612	0.00476	0.11127	0.02088	0.11603	0.13215	0.114	0.026
R5	80000	1465000	0.18759	0.03404	0.00983	0.22163	0.04387	0.23146	0.2655	0.227	0.055
R6	80000	1467000	0.1526	0.02623	0.00799	0.17883	0.03422	0.18682	0.21305	0.183	0.043
R7	78000	1467000	0.18131	0.02998	0.00898	0.21129	0.03896	0.22027	0.25025	0.216	0.049

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	3.25518	0.36543	0.13125	3.62061	0.49668	3.75186	4.11729	3.686	0.610
R2	79550	1465700	4.28484	0.5809	0.22945	4.86574	0.81035	5.09519	5.67609	4.980	0.984
R3	79550	1466300	3.94305	0.71175	0.24235	4.6548	0.9541	4.89715	5.6089	4.776	1.178
R4	78000	1465000	1.71056	0.32391	0.08968	2.03447	0.41359	2.12415	2.44806	2.079	0.521
R5	80000	1465000	2.78614	0.49539	0.14519	3.28153	0.64058	3.42672	3.92211	3.354	0.803
R6	80000	1467000	2.00453	0.32703	0.11179	2.33156	0.43882	2.44335	2.77038	2.387	0.542
R7	78000	1467000	2.32518	0.38748	0.11701	2.71266	0.50449	2.82967	3.21715	2.771	0.631

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.35453	0.05142	0.01933	0.40595	0.07075	0.42528	0.4767	0.416	0.086
2nd Higest	79550	1466300	0.31157	0.04367	0.0156	0.35524	0.05927	0.37084	0.41451	0.363	0.073

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300		0.71175	0.24235		0.9541	4.51429	5.09519		
	79550	1465700	4.28484			4.86574					
Dates			87011224	87072424	87072424	87011224	87072424	87011224	87011224		

Scenario 4PM Year 87

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.10195	0.01349	0.00542	0.11544	0.01891	0.12086	0.13435	0.118	0.023
R2	79550	1465700	0.36243	0.05203	0.01967	0.41446	0.0717	0.43413	0.48616	0.424	0.087
R3	79550	1466300	0.34266	0.04641	0.01677	0.38907	0.06318	0.40584	0.45225	0.397	0.077
R4	78000	1465000	0.0945	0.01629	0.00483	0.11079	0.02112	0.11562	0.13191	0.113	0.026
R5	80000	1465000	0.19091	0.03447	0.00999	0.22538	0.04446	0.23537	0.26984	0.230	0.056
R6	80000	1467000	0.16414	0.02809	0.00853	0.19223	0.03662	0.20076	0.22885	0.196	0.046
R7	78000	1467000	0.18381	0.0303	0.0091	0.21411	0.0394	0.22321	0.25351	0.219	0.049

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.66058	0.35239	0.13125	3.01297	0.48364	3.14422	3.49661	3.079	0.591
R2	79550	1465700	4.33766	0.59966	0.2311	4.93732	0.83076	5.16842	5.76808	5.053	1.011
R3	79550	1466300	3.94481	0.71407	0.24361	4.65888	0.95768	4.90249	5.61656	4.781	1.182
R4	78000	1465000	2.02204	0.37177	0.10609	2.39381	0.47786	2.4999	2.87167	2.447	0.601
R5	80000	1465000	3.1177	0.5434	0.162	3.6611	0.7054	3.8231	4.3665	3.742	0.883
R6	80000	1467000	2.00453	0.32703	0.11179	2.33156	0.43882	2.44335	2.77038	2.387	0.542
R7	78000	1467000	2.32797	0.38801	0.11713	2.71598	0.50514	2.83311	3.22112	2.775	0.632

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.36243	0.05203	0.01967	0.41446	0.0717	0.43413	0.48616	0.424	0.087
2nd Higest	79550	1466300	0.34266	0.04641	0.01677	0.38907	0.06318	0.40584	0.45225	0.397	0.077

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300		0.71407	0.24361		0.95768		5.15373		
	79550	1465700	4.33766			4.92263		4.56876			
Dates			87011224	87072424	87072424	87011224	87072424	87011224	87011224		

Scenario 5PM **Year 87**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.11126	0.01505	0.00585	0.12631	0.0209	0.13216	0.14721	0.129	0.025
R2	79550	1465700	0.36144	0.05105	0.0194	0.41249	0.07045	0.43189	0.48294	0.422	0.086
R3	79550	1466300	0.3634	0.05052	0.01823	0.41392	0.06875	0.43215	0.48267	0.423	0.084
R4	78000	1465000	0.09929	0.01691	0.00502	0.1162	0.02193	0.12122	0.13813	0.119	0.027
R5	80000	1465000	0.19642	0.03526	0.01027	0.23168	0.04553	0.24195	0.27721	0.237	0.057
R6	80000	1467000	0.17539	0.02989	0.00905	0.20528	0.03894	0.21433	0.24422	0.210	0.049
R7	78000	1467000	0.1722	0.02822	0.00852	0.20042	0.03674	0.20894	0.23716	0.205	0.046

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.6484	0.3524	0.13125	3.0008	0.48365	3.13205	3.48445	3.066	0.591
R2	79550	1465700	3.85831	0.59962	0.20786	4.45793	0.80748	4.66579	5.26541	4.562	0.995
R3	79550	1466300	3.94481	0.71407	0.24361	4.65888	0.95768	4.90249	5.61656	4.781	1.182
R4	78000	1465000	2.03782	0.37831	0.10824	2.41613	0.48655	2.52437	2.90268	2.470	0.612
R5	80000	1465000	2.91903	0.50558	0.15153	3.42461	0.65711	3.57614	4.08172	3.500	0.822
R6	80000	1467000	2.00453	0.32703	0.11179	2.33156	0.43882	2.44335	2.77038	2.387	0.542
R7	78000	1467000	2.32797	0.38801	0.11713	2.71598	0.50514	2.83311	3.22112	2.775	0.632

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.3634	0.05105	0.0194	0.41445	0.07045	0.43385	0.4849	0.424	0.086
2nd Higest	79550	1466300	0.36144	0.05052	0.01823	0.41196	0.06875	0.43019	0.48071	0.421	0.084

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300	3.94481	0.71407	0.24361	4.65888	0.95768	4.18842	4.90249	4.424	0.677
Dates			87011224	87072424	87011224	87011224	87011224	87011224	87011224		

Scenario 6PM **Year 87**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.10506	0.01403	0.00543	0.11909	0.01946	0.12452	0.13855	0.122	0.024
R2	79550	1465700	0.36861	0.05195	0.01966	0.42056	0.07161	0.44022	0.49217	0.430	0.087
R3	79550	1466300	0.40029	0.05703	0.02022	0.45732	0.07725	0.47754	0.53457	0.467	0.095
R4	78000	1465000	0.09887	0.01671	0.00496	0.11558	0.02167	0.12054	0.13725	0.118	0.027
R5	80000	1465000	0.19699	0.03538	0.0103	0.23237	0.04568	0.24267	0.27805	0.238	0.057
R6	80000	1467000	0.18425	0.03154	0.00939	0.21579	0.04093	0.22518	0.25672	0.220	0.051
R7	78000	1467000	0.1657	0.02722	0.00819	0.19292	0.03541	0.20111	0.22833	0.197	0.044

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.64838	0.3524	0.13125	3.00078	0.48365	3.13203	3.48443	3.066	0.591
R2	79550	1465700	3.85811	0.65787	0.22438	4.51598	0.88225	4.74036	5.39823	4.628	1.089
R3	79550	1466300	3.94481	0.71407	0.24361	4.65888	0.95768	4.90249	5.61656	4.781	1.182
R4	78000	1465000	2.23505	0.43109	0.12332	2.66614	0.55441	2.78946	3.22055	2.728	0.697
R5	80000	1465000	3.02573	0.52794	0.15714	3.55367	0.68508	3.71081	4.23875	3.632	0.858
R6	80000	1467000	1.82904	0.32703	0.09171	2.15607	0.41874	2.24778	2.57481	2.202	0.527
R7	78000	1467000	2.32668	0.38781	0.11705	2.71449	0.50486	2.83154	3.21935	2.773	0.631

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.40029	0.05703	0.02022	0.45732	0.07725	0.47754	0.53457	0.467	0.095
2nd Higest	79550	1466300	0.36861	0.05195	0.01966	0.42056	0.07161	0.44022	0.49217	0.430	0.087

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300	3.94481	0.71407	0.24361	4.65888	0.95768	4.18842	4.90249	4.424	0.677
Dates			87072424	87072424	87072424	87072424	87072424	87072424	87072424		

Scenario 7PM **Year 87**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.10484	0.01458	0.00556	0.11942	0.02014	0.12498	0.13956	0.122	0.025
R2	79550	1465700	0.37216	0.05357	0.01985	0.42573	0.07342	0.44558	0.49915	0.436	0.090
R3	79550	1466300	0.42685	0.06216	0.02177	0.48901	0.08393	0.51078	0.57294	0.500	0.103
R4	78000	1465000	0.0948	0.01624	0.00481	0.11104	0.02105	0.11585	0.13209	0.113	0.026
R5	80000	1465000	0.19747	0.03568	0.01033	0.23315	0.04601	0.24348	0.27916	0.238	0.058
R6	80000	1467000	0.18977	0.03256	0.00968	0.22233	0.04224	0.23201	0.26457	0.227	0.053
R7	78000	1467000	0.15095	0.02481	0.00745	0.17576	0.03226	0.18321	0.20802	0.179	0.040

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.64729	0.3524	0.13125	2.99969	0.48365	3.13094	3.48334	3.065	0.591
R2	79550	1465700	3.84278	0.6578	0.22436	4.50058	0.88216	4.72494	5.38274	4.613	1.089
R3	79550	1466300	3.94481	0.71407	0.24361	4.65888	0.95768	4.90249	5.61656	4.781	1.182
R4	78000	1465000	2.31453	0.45665	0.13093	2.77118	0.58758	2.90211	3.35876	2.837	0.738
R5	80000	1465000	3.03117	0.52887	0.15743	3.56004	0.6863	3.71747	4.24634	3.639	0.859
R6	80000	1467000	2.00853	0.32703	0.09211	2.33556	0.41914	2.42767	2.7547	2.382	0.528
R7	78000	1467000	1.92855	0.31496	0.09623	2.24351	0.41119	2.33974	2.6547	2.292	0.513

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.42685	0.06216	0.02177	0.48901	0.08393	0.51078	0.57294	0.500	0.103
2nd Higest	79550	1466300	0.37216	0.05357	0.01985	0.42573	0.07342	0.44558	0.49915	0.436	0.090

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300	3.94481	0.71407	0.24361	4.65888	0.95768	4.18842	4.90249	4.424	0.677
Dates			87072424	87072424	87072424	87072424	87072424	87072424	87072424		

Scenario 8PM   Year 87

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.11659	0.01632	0.00603	0.13291	0.02235	0.13894	0.15526	0.136	0.027
R2	79550	1465700	0.37642	0.05481	0.02015	0.43123	0.07496	0.45138	0.50619	0.441	0.092
R3	79550	1466300	0.44851	0.06616	0.02302	0.51467	0.08918	0.53769	0.60385	0.526	0.110
R4	78000	1465000	0.09626	0.01663	0.00492	0.11289	0.02155	0.11781	0.13444	0.115	0.027
R5	80000	1465000	0.20042	0.03642	0.01049	0.23684	0.04691	0.24733	0.28375	0.242	0.059
R6	80000	1467000	0.19105	0.03285	0.00971	0.2239	0.04256	0.23361	0.26646	0.229	0.053
R7	78000	1467000	0.136	0.02231	0.00667	0.15831	0.02898	0.16498	0.18729	0.162	0.036

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.64729	0.3524	0.13125	2.99969	0.48365	3.13094	3.48334	3.065	0.591
R2	79550	1465700	3.49588	0.61711	0.20463	4.11299	0.82174	4.31762	4.93473	4.215	1.017
R3	79550	1466300	3.96012	0.72714	0.24924	4.68726	0.97638	4.9365	5.66364	4.812	1.205
R4	78000	1465000	2.18671	0.45262	0.13097	2.63933	0.58359	2.7703	3.22292	2.705	0.733
R5	80000	1465000	3.04237	0.53081	0.15802	3.57318	0.68883	3.7312	4.26201	3.652	0.862
R6	80000	1467000	2.00881	0.32703	0.09211	2.33584	0.41914	2.42795	2.75498	2.382	0.528
R7	78000	1467000	1.92855	0.31496	0.09623	2.24351	0.41119	2.33974	2.6547	2.292	0.513

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.44851	0.06616	0.02302	0.51467	0.08918	0.53769	0.60385	0.526	0.110
2nd Higest	79550	1466300	0.37642	0.05481	0.02015	0.43123	0.07496	0.45138	0.50619	0.441	0.092

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300	3.96012	0.72714	0.24924	4.68727	0.97638	4.20936	4.93651	4.448	0.690
Dtaes			87072424	87030724	87030724	87072424	87030724	87072424	87072424		

Scenario 9PM Year 87

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.12412	0.01758	0.0064	0.1417	0.02398	0.1481	0.16568	0.145	0.029
R2	79550	1465700	0.3807	0.05627	0.02049	0.43697	0.07676	0.45746	0.51373	0.447	0.094
R3	79550	1466300	0.46337	0.0694	0.02415	0.53277	0.09355	0.55692	0.62632	0.545	0.115
R4	78000	1465000	0.09781	0.01685	0.00492	0.11466	0.02177	0.11958	0.13643	0.117	0.027
R5	80000	1465000	0.19782	0.03595	0.01036	0.23377	0.04631	0.24413	0.28008	0.239	0.058
R6	80000	1467000	0.19198	0.03287	0.00968	0.22485	0.04255	0.23453	0.2674	0.230	0.053
R7	78000	1467000	0.14381	0.02385	0.00706	0.16766	0.03091	0.17472	0.19857	0.171	0.039

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.64698	0.3524	0.13125	2.99938	0.48365	3.13063	3.48303	3.065	0.591
R2	79550	1465700	3.5231	0.61711	0.20463	4.14021	0.82174	4.34484	4.96195	4.243	1.017
R3	79550	1466300	3.96012	0.72714	0.24924	4.68726	0.97638	4.9365	5.66364	4.812	1.205
R4	78000	1465000	2.16227	0.45077	0.13059	2.61304	0.58136	2.74363	3.1944	2.678	0.730
R5	80000	1465000	3.04236	0.5308	0.15802	3.57316	0.68882	3.73118	4.26198	3.652	0.862
R6	80000	1467000	2.00881	0.32703	0.09211	2.33584	0.41914	2.42795	2.75498	2.382	0.528
R7	78000	1467000	2.03986	0.3353	0.10172	2.37516	0.43702	2.47688	2.81218	2.426	0.546

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.46337	0.0694	0.02415	0.53277	0.09355	0.55692	0.62632	0.545	0.115
2nd Higest	79550	1466300	0.3807	0.05627	0.02049	0.43697	0.07676	0.45746	0.51373	0.447	0.094

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300	3.96012	0.72714	0.24924	4.68727	0.97638	4.20936	4.93651	4.448	0.690
Dates			87072424	87072424	87072424	87072424	87072424	87072424	87072424		

Scenario 10PM Year 87

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.12844	0.01901	0.00678	0.14745	0.02579	0.15423	0.17324	0.151	0.032
R2	79550	1465700	0.38011	0.05711	0.02057	0.43722	0.07768	0.45779	0.5149	0.448	0.095
R3	79550	1466300	0.47693	0.0714	0.02461	0.54833	0.09601	0.57294	0.64434	0.561	0.118
R4	78000	1465000	0.0966	0.01675	0.00491	0.11335	0.02166	0.11826	0.13501	0.116	0.027
R5	80000	1465000	0.19415	0.03532	0.01016	0.22947	0.04548	0.23963	0.27495	0.235	0.057
R6	80000	1467000	0.19388	0.03336	0.00981	0.22724	0.04317	0.23705	0.27041	0.232	0.054
R7	78000	1467000	0.13756	0.02305	0.00674	0.16061	0.02979	0.16735	0.1904	0.164	0.037

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.61055	0.3524	0.13125	2.96295	0.48365	3.0942	3.4466	3.029	0.591
R2	79550	1465700	3.5231	0.59617	0.19027	4.11927	0.78644	4.30954	4.90571	4.214	0.978
R3	79550	1466300	4.04439	0.72714	0.24924	4.77153	0.97638	5.02077	5.74791	4.896	1.205
R4	78000	1465000	2.16227	0.45077	0.1306	2.61304	0.58137	2.74364	3.19441	2.678	0.730
R5	80000	1465000	3.04233	0.5308	0.15802	3.57313	0.68882	3.73115	4.26195	3.652	0.862
R6	80000	1467000	1.99974	0.32703	0.09197	2.32677	0.419	2.41874	2.74577	2.373	0.528
R7	78000	1467000	1.98857	0.33084	0.09896	2.31941	0.4298	2.41837	2.74921	2.369	0.538

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.47693	0.0714	0.02461	0.54833	0.09601	0.57294	0.64434	0.561	0.118
2nd Higest	79550	1466300	0.38011	0.05711	0.02057	0.43722	0.07768	0.45779	0.5149	0.448	0.095

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300	4.04439	0.72714	0.24924	4.68727	0.97638	4.26046	4.93651	4.490	0.631
Dates			87072424	87072424	87072424	87072424	87072424	87072424	87072424		

Scenario 11PM Year 87

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.14032	0.02107	0.00738	0.16139	0.02845	0.16877	0.18984	0.165	0.035
R2	79550	1465700	0.38868	0.05942	0.02117	0.4481	0.08059	0.46927	0.52869	0.459	0.099
R3	79550	1466300	0.47889	0.07291	0.02504	0.5518	0.09795	0.57684	0.64975	0.564	0.121
R4	78000	1465000	0.09245	0.01616	0.0047	0.10861	0.02086	0.11331	0.12947	0.111	0.026
R5	80000	1465000	0.19288	0.03533	0.01009	0.22821	0.04542	0.2383	0.27363	0.233	0.057
R6	80000	1467000	0.19057	0.03303	0.00966	0.2236	0.04269	0.23326	0.26629	0.228	0.054
R7	78000	1467000	0.13703	0.02312	0.0067	0.16015	0.02982	0.16685	0.18997	0.164	0.037

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.61055	0.3524	0.13125	2.96295	0.48365	3.0942	3.4466	3.029	0.591
R2	79550	1465700	3.97896	0.76684	0.22324	4.7458	0.99008	4.96904	5.73588	4.857	1.242
R3	79550	1466300	4.04489	0.72714	0.24924	4.77203	0.97638	5.02127	5.74841	4.897	1.205
R4	78000	1465000	2.06144	0.38591	0.11473	2.44735	0.50064	2.56208	2.94799	2.505	0.627
R5	80000	1465000	2.91468	0.50971	0.15156	3.42439	0.66127	3.57595	4.08566	3.500	0.828
R6	80000	1467000	1.82904	0.32703	0.09171	2.15607	0.41874	2.24778	2.57481	2.202	0.527
R7	78000	1467000	1.80629	0.31705	0.08763	2.12334	0.40468	2.21097	2.52802	2.167	0.510

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1465700	0.47889	0.07291	0.02504	0.5518	0.09795	0.57684	0.64975	0.564	0.121
2nd Higest	79550	1466300	0.38868	0.05942	0.02117	0.4481	0.08059	0.46927	0.52869	0.459	0.099

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Higest	79550	1466300	4.04489		0.24924			4.26096		4.045	
	79550	1465700		0.76684		4.7458	0.99008		4.96904		
Dates			87121424	87091424	87111824	87121424	87121424	87121424	87121424		

Scenario 7AM | Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.12469	0.02066	0.00699	0.14535	0.02765	0.15234	0.173	0.149	0.034
R2	79550	1465700	0.52601	0.08554	0.02979	0.61155	0.11533	0.64134	0.72688	0.626	0.142
R3	79550	1466300	0.42534	0.0699	0.02299	0.49524	0.09289	0.51823	0.58813	0.507	0.115
R4	78000	1465000	0.05937	0.01032	0.00293	0.06969	0.01325	0.07262	0.08294	0.071	0.017
R5	80000	1465000	0.23026	0.04322	0.01206	0.27348	0.05528	0.28554	0.32876	0.280	0.070
R6	80000	1467000	0.18851	0.03335	0.00939	0.22186	0.04274	0.23125	0.2646	0.227	0.054
R7	78000	1467000	0.14558	0.02599	0.00722	0.17157	0.03321	0.17879	0.20478	0.175	0.042

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.79299	0.58496	0.21351	3.37795	0.79847	3.59146	4.17642	3.485	0.978
R2	79550	1465700	5.07339	0.89839	0.33849	5.97178	1.23688	6.31027	7.20866	6.141	1.510
R3	79550	1466300	3.71784	0.67024	0.2178	4.38808	0.88804	4.60588	5.27612	4.497	1.102
R4	78000	1465000	1.79646	0.35051	0.11149	2.14697	0.462	2.25846	2.60897	2.203	0.575
R5	80000	1465000	2.28328	0.4096	0.12238	2.69288	0.53198	2.81526	3.22486	2.754	0.666
R6	80000	1467000	2.28925	0.36549	0.11407	2.65474	0.47956	2.76881	3.1343	2.712	0.598
R7	78000	1467000	2.20811	0.41391	0.10778	2.62202	0.52169	2.7298	3.14371	2.676	0.662

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.52601	0.08554	0.02979	0.61155	0.11533	0.64134	0.72688	0.626	0.142
2nd Highest	79550	1466300	0.42534	0.0699	0.02299	0.49524	0.09289	0.51823	0.58813	0.507	0.115

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300									
	79550	1465700	5.07339	0.89839	0.33849	5.97178	1.23688	5.41188	6.31027		
Dates			88113024	88113024	88113024	88113024	88113024	88113024	88113024		

Scenario 8 AM | Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.11706	0.02012	0.00683	0.13718	0.02695	0.14401	0.16413	0.141	0.033
R2	79550	1465700	0.52362	0.08449	0.02946	0.60811	0.11395	0.63757	0.72206	0.623	0.140
R3	79550	1466300	0.38519	0.06505	0.02124	0.45024	0.08629	0.47148	0.53653	0.461	0.107
R4	78000	1465000	0.05895	0.01014	0.0029	0.06909	0.01304	0.07199	0.08213	0.071	0.016
R5	80000	1465000	0.22161	0.04176	0.01163	0.26337	0.05339	0.275	0.31676	0.269	0.067
R6	80000	1467000	0.18175	0.03231	0.00915	0.21406	0.04146	0.22321	0.25552	0.219	0.052
R7	78000	1467000	0.14824	0.02645	0.00736	0.17469	0.03381	0.18205	0.2085	0.178	0.043

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.94846	0.71656	0.25554	3.66502	0.9721	3.92056	4.63712	3.793	1.194
R2	79550	1465700	4.57991	0.81427	0.30726	5.39418	1.12153	5.70144	6.51571	5.548	1.369
R3	79550	1466300	3.87436	0.60041	0.19199	4.47477	0.7924	4.66676	5.26717	4.571	0.985
R4	78000	1465000	1.79646	0.35051	0.11149	2.14697	0.462	2.25846	2.60897	2.203	0.575
R5	80000	1465000	2.28328	0.4096	0.12238	2.69288	0.53198	2.81526	3.22486	2.754	0.666
R6	80000	1467000	2.29003	0.36552	0.11408	2.65555	0.4796	2.76963	3.13515	2.713	0.598
R7	78000	1467000	2.20811	0.41391	0.10778	2.62202	0.52169	2.7298	3.14371	2.676	0.662

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.52362	0.08449	0.02946	0.60811	0.11395	0.63757	0.72206	0.623	0.140
2nd Highest	79550	1466300	0.38519	0.06505	0.02124	0.45024	0.08629	0.47148	0.53653	0.461	0.107

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300									
	79550	1465700	4.57991	0.81427	0.30726	5.39418	1.12152	4.88717	5.70144		
Dates			88113024	88113024	88113024	88113024	88113024	88113024	88113024		

Scenario 9AM   Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.11414	0.01945	0.0066	0.13359	0.02605	0.14019	0.15964	0.137	0.032
R2	79550	1465700	0.51285	0.08246	0.02891	0.59531	0.11137	0.62422	0.70668	0.610	0.137
R3	79550	1466300	0.37111	0.06322	0.02076	0.43433	0.08398	0.45509	0.51831	0.445	0.104
R4	78000	1465000	0.05524	0.00966	0.00279	0.0649	0.01245	0.06769	0.07735	0.066	0.016
R5	80000	1465000	0.21345	0.04021	0.01121	0.25366	0.05142	0.26487	0.30508	0.259	0.065
R6	80000	1467000	0.17679	0.03147	0.00896	0.20826	0.04043	0.21722	0.24869	0.213	0.051
R7	78000	1467000	0.15056	0.02675	0.00748	0.17731	0.03423	0.18479	0.21154	0.181	0.043

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.94846	0.71656	0.25554	3.66502	0.9721	3.92056	4.63712	3.793	1.194
R2	79550	1465700	4.28581	0.79221	0.27974	5.07802	1.07195	5.35776	6.14997	5.218	1.318
R3	79550	1466300	3.87436	0.59875	0.18359	4.47311	0.78234	4.6567	5.25545	4.565	0.977
R4	78000	1465000	1.79646	0.35051	0.11149	2.14697	0.462	2.25846	2.60897	2.203	0.575
R5	80000	1465000	2.28328	0.4096	0.12238	2.69288	0.53198	2.81526	3.22486	2.754	0.666
R6	80000	1467000	2.11151	0.32538	0.10084	2.43689	0.42622	2.53773	2.86311	2.487	0.531
R7	78000	1467000	2.20128	0.41277	0.10749	2.61405	0.52026	2.72154	3.13431	2.668	0.660

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.51285	0.08246	0.02891	0.59531	0.11137	0.62422	0.70668	0.610	0.137
2nd Highest	79550	1466300	0.37111	0.06322	0.02076	0.43433	0.08398	0.45509	0.51831	0.445	0.104

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.28581	0.79221	0.27974	5.06066	1.0498	4.55306	5.31825		
Dates			88113024	88041824	88113024	88041824	88041824	88113024	88041824		

Scenario10 AM Year88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.13307	0.02053	0.00743	0.1536	0.02796	0.16103	0.18156	0.157	0.034
R2	79550	1465700	0.37747	0.05963	0.02111	0.4371	0.08074	0.45821	0.51784	0.448	0.099
R3	79550	1466300	0.32961	0.0518	0.01748	0.38141	0.06928	0.39889	0.45069	0.390	0.086
R4	78000	1465000	0.09099	0.01611	0.00466	0.1071	0.02077	0.11176	0.12787	0.109	0.026
R5	80000	1465000	0.20349	0.03766	0.01068	0.24115	0.04834	0.25183	0.28949	0.246	0.061
R6	80000	1467000	0.121	0.02145	0.00634	0.14245	0.02779	0.14879	0.17024	0.146	0.035
R7	78000	1467000	0.19391	0.03307	0.00965	0.22698	0.04272	0.23663	0.2697	0.232	0.054

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.87403	0.3896	0.12943	3.26363	0.51903	3.39306	3.78266	3.328	0.642
R2	79550	1465700	3.1506	0.64154	0.20181	3.79214	0.84335	3.99395	4.63549	3.893	1.050
R3	79550	1466300	4.31629	0.63212	0.1803	4.94841	0.81242	5.12871	5.76083	5.039	1.021
R4	78000	1465000	1.36795	0.29945	0.07988	1.6674	0.37933	1.74728	2.04673	1.707	0.480
R5	80000	1465000	2.3478	0.44809	0.12288	2.79589	0.57097	2.91877	3.36686	2.857	0.721
R6	80000	1467000	1.81498	0.28527	0.10347	2.10025	0.38874	2.20372	2.48899	2.152	0.477
R7	78000	1467000	2.5812	0.43458	0.12964	3.01578	0.56422	3.14542	3.58	3.081	0.706

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.37747	0.05963	0.02111	0.4371	0.08074	0.45821	0.51784	0.448	0.099
2nd Highest	79550	1466300	0.32961	0.0518	0.01748	0.38141	0.06928	0.39889	0.45069	0.390	0.086

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.31629c			4.94840c		4.49658c	5.12870c		
	79550	1465700		0.64154	0.20181		0.84335				
Dates			87091424	87080224	87080224	87080224	87091424	87080224	87091424		

Scenario11 AM Year88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.10186	0.01765	0.00605	0.11951	0.0237	0.12556	0.14321	0.123	0.029
R2	79550	1465700	0.48184	0.07699	0.02742	0.55883	0.10441	0.58625	0.66324	0.573	0.128
R3	79550	1466300	0.32271	0.05416	0.01809	0.37687	0.07225	0.39496	0.44912	0.386	0.089
R4	78000	1465000	0.05773	0.01002	0.00294	0.06775	0.01296	0.07069	0.08071	0.069	0.016
R5	80000	1465000	0.2042	0.03802	0.01072	0.24222	0.04874	0.25294	0.29096	0.248	0.061
R6	80000	1467000	0.17609	0.03098	0.00892	0.20707	0.0399	0.21599	0.24697	0.212	0.050
R7	78000	1467000	0.14835	0.02615	0.00738	0.1745	0.03353	0.18188	0.20803	0.178	0.042

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.91933	0.70005	0.24703	3.61938	0.94708	3.86641	4.56646	3.743	1.165
R2	79550	1465700	4.61824	0.79693	0.25884	5.41517	1.05577	5.67401	6.47094	5.545	1.310
R3	79550	1466300	3.87418	0.66013	0.19586	4.53431	0.85599	4.73017	5.3903	4.632	1.072
R4	78000	1465000	1.79444	0.35039	0.11147	2.14483	0.46186	2.2563	2.60669	2.201	0.574
R5	80000	1465000	2.30994	0.414	0.12384	2.72394	0.53784	2.84778	3.26178	2.786	0.673
R6	80000	1467000	1.89965	0.28284	0.08557	2.18249	0.36841	2.26806	2.5509	2.225	0.461
R7	78000	1467000	1.96111	0.34028	0.09499	2.30139	0.43527	2.39638	2.73666	2.349	0.548

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.48184	0.07699	0.02742	0.55883	0.10441	0.58625	0.66324	0.573	0.128
2nd Highest	79550	1466300	0.32271	0.05416	0.01809	0.37687	0.07225	0.39496	0.44912	0.386	0.089

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.61824	0.79693	0.25884	5.21997	1.05577	4.85722	5.45895		
Dates			88032024	88041824	88041824	88032024	88041824	88032024	88032024		

Scenario 12PM Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.08584	0.01523	0.00529	0.10107	0.02052	0.10636	0.12159	0.104	0.025
R2	79550	1465700	0.46582	0.07349	0.02644	0.53931	0.09993	0.56575	0.63924	0.553	0.123
R3	79550	1466300	0.30368	0.05124	0.01747	0.35492	0.06871	0.37239	0.42363	0.364	0.085
R4	78000	1465000	0.05945	0.01027	0.00303	0.06972	0.0133	0.07275	0.08302	0.071	0.017
R5	80000	1465000	0.20346	0.03776	0.01068	0.24122	0.04844	0.2519	0.28966	0.247	0.061
R6	80000	1467000	0.17918	0.03113	0.00904	0.21031	0.04017	0.21935	0.25048	0.215	0.050
R7	78000	1467000	0.15135	0.02651	0.00751	0.17786	0.03402	0.18537	0.21188	0.182	0.043

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.91932	0.70001	0.247	3.61933	0.94701	3.86633	4.56634	3.743	1.165
R2	79550	1465700	4.19036	0.73169	0.24014	4.92205	0.97183	5.16219	5.89388	5.042	1.205
R3	79550	1466300	4.0526	0.60305	0.184	4.65565	0.78705	4.83965	5.4427	4.748	0.983
R4	78000	1465000	1.79402	0.3502	0.1114	2.14422	0.4616	2.25562	2.60582	2.200	0.574
R5	80000	1465000	2.30994	0.414	0.12384	2.72394	0.53784	2.84778	3.26178	2.786	0.673
R6	80000	1467000	1.59433	0.24108	0.07457	1.83541	0.31565	1.90998	2.15106	1.873	0.394
R7	78000	1467000	1.95683	0.30952	0.09476	2.26635	0.40428	2.36111	2.67063	2.314	0.505

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.46582	0.07349	0.02644	0.53931	0.09993	0.56575	0.63924	0.553	0.123
2nd Highest	79550	1466300	0.30368	0.05124	0.01747	0.35492	0.06871	0.37239	0.42363	0.364	0.085

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.19036	0.73169		4.85302	0.97182	4.40835	5.09316		
	78400	1465800			0.247						
Dates			88032024	88041824	88031124	88041824	88041824	88032024	88041824		

Scenario 1PM Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.07726	0.01357	0.00475	0.09083	0.01832	0.09558	0.10915	0.093	0.023
R2	79550	1465700	0.4404	0.06806	0.02479	0.50846	0.09285	0.53325	0.60131	0.521	0.114
R3	79550	1466300	0.28932	0.04836	0.01687	0.33768	0.06523	0.35455	0.40291	0.346	0.080
R4	78000	1465000	0.05929	0.0102	0.00301	0.06949	0.01321	0.0725	0.0827	0.071	0.017
R5	80000	1465000	0.20992	0.03866	0.01101	0.24858	0.04967	0.25959	0.29825	0.254	0.062
R6	80000	1467000	0.18117	0.03116	0.00913	0.21233	0.04029	0.22146	0.25262	0.217	0.051
R7	78000	1467000	0.15608	0.02717	0.00776	0.18325	0.03493	0.19101	0.21818	0.187	0.044

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.53128	0.56598	0.20446	3.09726	0.77044	3.30172	3.8677	3.199	0.945
R2	79550	1465700	4.17752	0.72268	0.23745	4.9002	0.96013	5.13765	5.86033	5.019	1.190
R3	79550	1466300	4.25388	0.61285	0.20034	4.86673	0.81319	5.06707	5.67992	4.967	1.008
R4	78000	1465000	1.79402	0.3502	0.1114	2.14422	0.4616	2.25562	2.60582	2.200	0.574
R5	80000	1465000	3.12588	0.53281	0.16659	3.65869	0.6994	3.82528	4.35809	3.742	0.871
R6	80000	1467000	1.44542	0.24654	0.07558	1.69196	0.32212	1.76754	2.01408	1.730	0.402
R7	78000	1467000	1.95677	0.3095	0.09476	2.26627	0.40426	2.36103	2.67053	2.314	0.505

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.4404	0.06806	0.02479	0.50846	0.09285	0.53325	0.60131	0.521	0.114
2nd Highest	79550	1466300	0.28932	0.04836	0.01687	0.33768	0.06523	0.35455	0.40291	0.346	0.080

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.25388			4.86673		4.45422	5.06707	4.660	0.575
	79550	1465700		0.72268	0.23745		0.96013				
Dates			88010124	88041824	88041824	88010124	88041824	88010124	88010124		

Scenario 2PM Year88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.06582	0.01151	0.0041	0.07733	0.01561	0.08143	0.09294	0.079	0.019
R2	79550	1465700	0.43809	0.06601	0.02436	0.5041	0.09037	0.52846	0.59447	0.516	0.111
R3	79550	1466300	0.30064	0.04827	0.01729	0.34891	0.06556	0.3662	0.41447	0.358	0.080
R4	78000	1465000	0.05941	0.01027	0.00306	0.06968	0.01333	0.07274	0.08301	0.071	0.017
R5	80000	1465000	0.21956	0.04022	0.0115	0.25978	0.05172	0.27128	0.3115	0.266	0.065
R6	80000	1467000	0.1764	0.02978	0.00882	0.20618	0.0386	0.215	0.24478	0.211	0.048
R7	78000	1467000	0.15312	0.02659	0.00762	0.17971	0.03421	0.18733	0.21392	0.184	0.043

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.02229	0.4439	0.15831	2.46619	0.60221	2.6245	3.0684	2.545	0.740
R2	79550	1465700	4.05457	0.72315	0.2376	4.77772	0.96075	5.01532	5.73847	4.897	1.191
R3	79550	1466300	4.25388	0.61285	0.20034	4.86673	0.81319	5.06707	5.67992	4.967	1.008
R4	78000	1465000	1.79402	0.3502	0.1114	2.14422	0.4616	2.25562	2.60582	2.200	0.574
R5	80000	1465000	3.12588	0.53281	0.16659	3.65869	0.6994	3.82528	4.35809	3.742	0.871
R6	80000	1467000	1.44542	0.24768	0.07583	1.6931	0.32351	1.76893	2.01661	1.731	0.404
R7	78000	1467000	1.76406	0.28771	0.08832	2.05177	0.37603	2.14009	2.4278	2.096	0.469

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.43809	0.06601	0.02436	0.5041	0.09037	0.52846	0.59447	0.516	0.111
2nd Highest	79550	1466300	0.30064	0.04827	0.01729	0.34891	0.06556	0.3662	0.41447	0.358	0.080

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.25388			4.86673		4.45422	5.06707		
	79550	1465700		0.72315	0.2376		0.96075				
Dates			88010124	88041824	88041824	88010124	88041824	88010124	88010124		

Scenario 3PM Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.05486	0.00917	0.00329	0.06403	0.01246	0.06732	0.07649	0.066	0.015
R2	79550	1465700	0.42858	0.06375	0.02377	0.49233	0.08752	0.5161	0.57985	0.504	0.107
R3	79550	1466300	0.3073	0.04865	0.01762	0.35595	0.06627	0.37357	0.42222	0.365	0.081
R4	78000	1465000	0.06492	0.01093	0.00328	0.07585	0.01421	0.07913	0.09006	0.077	0.018
R5	80000	1465000	0.22445	0.04089	0.01175	0.26534	0.05264	0.27709	0.31798	0.271	0.066
R6	80000	1467000	0.19097	0.0322	0.0096	0.22317	0.0418	0.23277	0.26497	0.228	0.052
R7	78000	1467000	0.15509	0.02675	0.0077	0.18184	0.03445	0.18954	0.21629	0.186	0.043

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.02127	0.44255	0.15747	2.46382	0.60002	2.62129	3.06384	2.543	0.737
R2	79550	1465700	4.02942	0.66042	0.21865	4.68984	0.87907	4.90849	5.56891	4.799	1.089
R3	79550	1466300	3.83272	0.59925	0.19096	4.43197	0.79021	4.62293	5.22218	4.527	0.982
R4	78000	1465000	1.76483	0.339	0.10729	2.10383	0.44629	2.21112	2.55012	2.157	0.555
R5	80000	1465000	3.12588	0.53281	0.16659	3.65869	0.6994	3.82528	4.35809	3.742	0.871
R6	80000	1467000	1.63195	0.29349	0.09514	1.92544	0.38863	2.02058	2.31407	1.973	0.482
R7	78000	1467000	1.91705	0.36466	0.0934	2.28171	0.45806	2.37511	2.73977	2.328	0.582

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.42858	0.06375	0.02377	0.49233	0.08752	0.5161	0.57985	0.504	0.107
2nd Highest	79550	1466300	0.3073	0.04865	0.01762	0.35595	0.06627	0.37357	0.42222	0.365	0.081

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300									
	79550	1465700	4.02942	0.66042	0.21865	4.52389	0.87907	4.23101	4.72548		
Dates			88032024	88032024	88041824	88032024	88041824	88041824	88032024		

Scenario 4PM   Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.05304	0.00881	0.00316	0.06185	0.01197	0.06501	0.07382	0.063	0.015
R2	79550	1465700	0.42174	0.06197	0.02336	0.48371	0.08533	0.50707	0.56904	0.495	0.104
R3	79550	1466300	0.3379	0.05183	0.01911	0.38973	0.07094	0.40884	0.46067	0.399	0.087
R4	78000	1465000	0.06475	0.01087	0.00328	0.07562	0.01415	0.0789	0.08977	0.077	0.018
R5	80000	1465000	0.22798	0.0415	0.01197	0.26948	0.05347	0.28145	0.32295	0.275	0.067
R6	80000	1467000	0.20013	0.03351	0.00996	0.23364	0.04347	0.2436	0.27711	0.239	0.054
R7	78000	1467000	0.14851	0.02544	0.00737	0.17395	0.03281	0.18132	0.20676	0.178	0.041

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	1.89341	0.3867	0.13295	2.28011	0.51965	2.41306	2.79976	2.347	0.641
R2	79550	1465700	3.65177	0.66046	0.2187	4.31223	0.87916	4.53093	5.19139	4.422	1.089
R3	79550	1466300	3.67659	0.56327	0.18749	4.23986	0.75076	4.42735	4.99062	4.334	0.929
R4	78000	1465000	1.52679	0.27449	0.08626	1.80128	0.36075	1.88754	2.16203	1.844	0.449
R5	80000	1465000	2.48962	0.45045	0.13216	2.94007	0.58261	3.07223	3.52268	3.006	0.730
R6	80000	1467000	1.63195	0.29535	0.09552	1.9273	0.39087	2.02282	2.31817	1.975	0.485
R7	78000	1467000	1.9336	0.36794	0.09413	2.30154	0.46207	2.39567	2.76361	2.349	0.587

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.42174	0.06197	0.02336	0.48371	0.08533	0.50707	0.56904	0.495	0.104
2nd Highest	79550	1466300	0.3379	0.05183	0.01911	0.38973	0.07094	0.40884	0.46067	0.399	0.087

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	3.67659c								
	79550	1465700		0.66046	0.2187	4.31223	3.87048	3.87048	4.53093		
Dates			3.87048	88041824	88041824	88041824	88041824	88041824	88041824		

Scenario 5PM Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.0531	0.00849	0.00298	0.06159	0.01147	0.06457	0.07306	0.063	0.014
R2	79550	1465700	0.43069	0.06285	0.02372	0.49354	0.08657	0.51726	0.58011	0.505	0.106
R3	79550	1466300	0.35647	0.05424	0.01989	0.41071	0.07413	0.4306	0.48484	0.421	0.091
R4	78000	1465000	0.06752	0.01142	0.00344	0.07894	0.01486	0.08238	0.0938	0.081	0.019
R5	80000	1465000	0.2337	0.04246	0.01226	0.27616	0.05472	0.28842	0.33088	0.282	0.069
R6	80000	1467000	0.20781	0.03481	0.01033	0.24262	0.04514	0.25295	0.28776	0.248	0.057
R7	78000	1467000	0.14074	0.02406	0.00699	0.1648	0.03105	0.17179	0.19585	0.168	0.039

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	1.70653	0.36642	0.1071	2.07295	0.47352	2.18005	2.54647	2.127	0.594
R2	79550	1465700	3.36789	0.55532	0.18716	3.92321	0.74248	4.11037	4.66569	4.017	0.918
R3	79550	1466300	3.67659	0.59622	0.20626	4.27281	0.80248	4.47907	5.07529	4.376	0.989
R4	78000	1465000	1.81635	0.28192	0.08533	2.09827	0.36725	2.1836	2.46552	2.141	0.459
R5	80000	1465000	2.73413	0.46662	0.1418	3.20075	0.60842	3.34255	3.80917	3.272	0.760
R6	80000	1467000	1.58039	0.33425	0.10522	1.91464	0.43947	2.01986	2.35411	1.967	0.547
R7	78000	1467000	1.8415	0.32907	0.08845	2.17057	0.41752	2.25902	2.58809	2.215	0.528

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.43069	0.06285	0.02372	0.49354	0.08657	0.51726	0.58011	0.505	0.106
2nd Highest	79550	1466300	0.35647	0.05424	0.01989	0.41071	0.07413	0.4306	0.48484	0.421	0.091

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	3.67659	0.59622	0.20626	4.24866	0.80248	3.8587	4.45491	4.066	0.550
Dates			88010124	88010124	88010124	88010124	88010124	88010124	88010124		

Scenario 6PM Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.05426	0.0089	0.00308	0.06316	0.01198	0.06624	0.07514	0.065	0.015
R2	79550	1465700	0.44254	0.06484	0.02418	0.50738	0.08902	0.53156	0.5964	0.519	0.109
R3	79550	1466300	0.38863	0.05848	0.0211	0.44711	0.07958	0.46821	0.52669	0.458	0.098
R4	78000	1465000	0.06028	0.01025	0.00311	0.07053	0.01336	0.07364	0.08389	0.072	0.017
R5	80000	1465000	0.23904	0.04359	0.01254	0.28263	0.05613	0.29517	0.33876	0.289	0.071
R6	80000	1467000	0.21479	0.03615	0.01074	0.25094	0.04689	0.26168	0.29783	0.256	0.059
R7	78000	1467000	0.13405	0.02293	0.00665	0.15698	0.02958	0.16363	0.18656	0.160	0.037

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	1.77961	0.39831	0.11837	2.17792	0.51668	2.29629	2.6946	2.237	0.647
R2	79550	1465700	3.18013	0.54024	0.18274	3.72037	0.72298	3.90311	4.44335	3.812	0.893
R3	79550	1466300	3.99769	0.53472	0.20559	4.53241	0.74031	4.738	5.27272	4.635	0.902
R4	78000	1465000	1.84669	0.28416	0.08581	2.13085	0.36997	2.21666	2.50082	2.174	0.463
R5	80000	1465000	3.04858	0.52101	0.15836	3.56959	0.67937	3.72795	4.24896	3.649	0.849
R6	80000	1467000	1.64803	0.33546	0.10548	1.98349	0.44094	2.08897	2.42443	2.036	0.549
R7	78000	1467000	1.98342	0.32755	0.09705	2.31097	0.4246	2.40802	2.73557	2.359	0.532

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.44254	0.06484	0.02418	0.50738	0.08902	0.53156	0.5964	0.519	0.109
2nd Highest	79550	1466300	0.38863	0.05848	0.0211	0.44711	0.07958	0.46821	0.52669	0.458	0.098

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	3.99769c		0.20559	4.52156c	0.73424	4.15914c	4.68301c		
	79550	1465700		0.54024							
Dates			88061124	88041824	88010424	88061124	88010424	88061124	88061124		

Scenario 7PM   Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.05209	0.00814	0.00267	0.06023	0.01081	0.0629	0.07104	0.062	0.013
R2	79550	1465700	0.45226	0.0669	0.02481	0.51916	0.09171	0.54397	0.61087	0.532	0.112
R3	79550	1466300	0.39754	0.06153	0.02189	0.45907	0.08342	0.48096	0.54249	0.470	0.102
R4	78000	1465000	0.05756	0.00962	0.00289	0.06718	0.01251	0.07007	0.07969	0.069	0.016
R5	80000	1465000	0.23975	0.04389	0.01257	0.28364	0.05646	0.29621	0.3401	0.290	0.071
R6	80000	1467000	0.21195	0.03597	0.01066	0.24792	0.04663	0.25858	0.29455	0.253	0.058
R7	78000	1467000	0.12013	0.02054	0.00593	0.14067	0.02647	0.1466	0.16714	0.144	0.033

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.42389	0.39827	0.11836	2.82216	0.51663	2.94052	3.33879	2.881	0.647
R2	79550	1465700	3.33842	0.58997	0.19675	3.92839	0.78672	4.12514	4.71511	4.027	0.973
R3	79550	1466300	3.99687	0.52386	0.1749	4.52073	0.69876	4.69563	5.21949	4.608	0.865
R4	78000	1465000	1.84669	0.28416	0.08581	2.13085	0.36997	2.21666	2.50082	2.174	0.463
R5	80000	1465000	3.07353	0.52568	0.15967	3.59921	0.68535	3.75888	4.28456	3.679	0.856
R6	80000	1467000	1.71102	0.33547	0.10548	2.04649	0.44095	2.15197	2.48744	2.099	0.549
R7	78000	1467000	2.07925	0.34633	0.10145	2.42558	0.44778	2.52703	2.87336	2.476	0.562

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.45226	0.0669	0.02481	0.51916	0.09171	0.54397	0.61087	0.532	0.112
2nd Highest	79550	1466300	0.39754	0.06153	0.02189	0.45907	0.08342	0.48096	0.54249	0.470	0.102

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	3.99687c			4.52073c		4.15832c	4.68218c		
	79550	1465700		0.58997	0.19675		0.78672				
Dates			88061124	88041824	88041824	88061124	88041824	88061124	88061124		

Scenario 8PM Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.06344	0.01023	0.00329	0.07367	0.01352	0.07696	0.08719	0.075	0.017
R2	79550	1465700	0.45434	0.06867	0.02514	0.52301	0.09381	0.54815	0.61682	0.536	0.115
R3	79550	1466300	0.40781	0.06375	0.02236	0.47156	0.08611	0.49392	0.55767	0.483	0.106
R4	78000	1465000	0.04936	0.00839	0.00253	0.05775	0.01092	0.06028	0.06867	0.059	0.014
R5	80000	1465000	0.23731	0.04355	0.01244	0.28086	0.05599	0.2933	0.33685	0.287	0.070
R6	80000	1467000	0.21295	0.03648	0.01077	0.24943	0.04725	0.2602	0.29668	0.255	0.059
R7	78000	1467000	0.10927	0.0187	0.00539	0.12797	0.02409	0.13336	0.15206	0.131	0.030

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.42958	0.50745	0.15076	2.93703	0.65821	3.08779	3.59524	3.012	0.824
R2	79550	1465700	3.33415	0.63775	0.20902	3.9719	0.84677	4.18092	4.81867	4.076	1.050
R3	79550	1466300	3.89548	0.52024	0.17268	4.41572	0.69292	4.5884	5.10864	4.502	0.858
R4	78000	1465000	1.84669	0.28416	0.08581	2.13085	0.36997	2.21666	2.50082	2.174	0.463
R5	80000	1465000	3.18497	0.54792	0.1656	3.73289	0.71352	3.89849	4.44641	3.816	0.892
R6	80000	1467000	1.89436	0.33549	0.10548	2.22985	0.44097	2.33533	2.67082	2.283	0.549
R7	78000	1467000	2.07052	0.34519	0.101	2.41571	0.44619	2.51671	2.8619	2.466	0.560

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.45434	0.06867	0.02514	0.52301	0.09381	0.54815	0.61682	0.536	0.115
2nd Highest	79550	1466300	0.40781	0.06375	0.02236	0.47156	0.08611	0.49392	0.55767	0.483	0.106

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	3.89548c			4.38157c		4.03377c	4.51985c		
Dates				0.63775	0.20902		0.84677				

Scenario 9PM Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.071	0.01188	0.00384	0.08288	0.01572	0.08672	0.0986	0.085	0.020
R2	79550	1465700	0.47098	0.0729	0.0263	0.54388	0.0992	0.57018	0.64308	0.557	0.122
R3	79550	1466300	0.4176	0.0659	0.0228	0.4835	0.0887	0.5063	0.5722	0.495	0.109
R4	78000	1465000	0.04848	0.00832	0.00249	0.0568	0.01081	0.05929	0.06761	0.058	0.014
R5	80000	1465000	0.23052	0.04236	0.01208	0.27288	0.05444	0.28496	0.32732	0.279	0.068
R6	80000	1467000	0.21239	0.0367	0.01078	0.24909	0.04748	0.25987	0.29657	0.254	0.060
R7	78000	1467000	0.10707	0.01835	0.00527	0.12542	0.02362	0.13069	0.14904	0.128	0.030

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.61624	0.50989	0.1518	3.12613	0.66169	3.27793	3.78782	3.202	0.828
R2	79550	1465700	3.57841	0.68508	0.23196	4.26349	0.91704	4.49545	5.18053	4.379	1.133
R3	79550	1466300	4.14705	0.53048	0.17192	4.67753	0.7024	4.84945	5.37993	4.763	0.872
R4	78000	1465000	1.84669	0.28416	0.08581	2.13085	0.36997	2.21666	2.50082	2.174	0.463
R5	80000	1465000	3.18499	0.54792	0.1656	3.73291	0.71352	3.89851	4.44643	3.816	0.892
R6	80000	1467000	1.9803	0.33691	0.10577	2.31721	0.44268	2.42298	2.75989	2.370	0.551
R7	78000	1467000	2.07052	0.34519	0.101	2.41571	0.44619	2.51671	2.8619	2.466	0.560

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.47098	0.0729	0.0263	0.54388	0.0992	0.57018	0.64308	0.557	0.122
2nd Highest	79550	1466300	0.4176	0.0659	0.0228	0.4835	0.0887	0.5063	0.5722	0.495	0.109

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.14705c			4.67753c		4.29496c	4.82544c		
	79550	1465700		0.68508	0.23196		0.89928				
Dates			88061124	88041824	88113024	88061124		88061124	88061124		

Scenario 10PM | Year 88

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.08239	0.0139	0.00446	0.09629	0.01836	0.10075	0.11465	0.099	0.023
R2	79550	1465700	0.47431	0.07468	0.02666	0.54899	0.10134	0.57565	0.65033	0.562	0.124
R3	79550	1466300	0.42198	0.06707	0.02303	0.48905	0.0901	0.51208	0.57915	0.501	0.111
R4	78000	1465000	0.04911	0.00852	0.00253	0.05763	0.01105	0.06016	0.06868	0.059	0.014
R5	80000	1465000	0.22563	0.04152	0.01182	0.26715	0.05334	0.27897	0.32049	0.273	0.067
R6	80000	1467000	0.22205	0.0389	0.01135	0.26095	0.05025	0.2723	0.3112	0.267	0.063
R7	78000	1467000	0.1059	0.01829	0.00521	0.12419	0.0235	0.1294	0.14769	0.127	0.030

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.78396	0.51729	0.15552	3.30125	0.67281	3.45677	3.97406	3.379	0.842
R2	79550	1465700	3.67642	0.68508	0.23122	4.3615	0.9163	4.59272	5.2778	4.477	1.132
R3	79550	1466300	4.14705	0.62427	0.18613	4.77132	0.8104	4.95745	5.58172	4.864	1.014
R4	78000	1465000	1.84669	0.28416	0.08581	2.13085	0.36997	2.21666	2.50082	2.174	0.463
R5	80000	1465000	3.18669	0.54831	0.16569	3.735	0.714	3.90069	4.449	3.818	0.893
R6	80000	1467000	1.96704	0.33684	0.10577	2.30388	0.44261	2.40965	2.74649	2.357	0.551
R7	78000	1467000	1.7325	0.28386	0.08239	2.01636	0.36625	2.09875	2.38261	2.058	0.460

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.47431	0.07468	0.02666	0.54899	0.10134	0.57565	0.65033	0.562	0.124
2nd Highest	79550	1466300	0.42198	0.06707	0.02303	0.48905	0.0901	0.51208	0.57915	0.501	0.111

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.14705c			4.67753c		4.29496c	4.82544c		
	79550	1465700		0.68508	0.23122		0.89928				
Dates			88061124	88041824	88113024	88061124	88041824	88061124	88061124		

Scenario 11PM | **Year 88**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.09183	0.01614	0.00523	0.10797	0.02137	0.1132	0.12934	0.111	0.027
R2	79550	1465700	0.48118	0.07658	0.02717	0.55776	0.10375	0.58493	0.66151	0.571	0.128
R3	79550	1466300	0.43173	0.06872	0.02342	0.50045	0.09214	0.52387	0.59259	0.512	0.114
R4	78000	1465000	0.05027	0.00868	0.00255	0.05895	0.01123	0.0615	0.07018	0.060	0.014
R5	80000	1465000	0.22874	0.04218	0.01198	0.27092	0.05416	0.2829	0.32508	0.277	0.068
R6	80000	1467000	0.21652	0.03833	0.01113	0.25485	0.04946	0.26598	0.30431	0.260	0.062
R7	78000	1467000	0.10671	0.01847	0.00524	0.12518	0.02371	0.13042	0.14889	0.128	0.030

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	3.29674	0.55877	0.17469	3.85551	0.73346	4.0302	4.58897	3.943	0.914
R2	79550	1465700	3.68362	0.74799	0.2332	4.43161	0.98119	4.66481	5.4128	4.548	1.223
R3	79550	1466300	4.02649	0.63067	0.21779	4.65716	0.84846	4.87495	5.50562	4.766	1.046
R4	78000	1465000	1.90526	0.30789	0.08581	2.21315	0.3937	2.29896	2.60685	2.256	0.496
R5	80000	1465000	3.6222	0.6217	0.18841	4.2439	0.81011	4.43231	5.05401	4.338	1.012
R6	80000	1467000	1.96717	0.33684	0.10577	2.30401	0.44261	2.40978	2.74662	2.357	0.551
R7	78000	1467000	1.71761	0.32409	0.08366	2.0417	0.40775	2.12536	2.44945	2.084	0.517

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.48118	0.07658	0.02717	0.55776	0.10375	0.58493	0.66151	0.571	0.128
2nd Highest	79550	1466300	0.43173	0.06872	0.02342	0.50045	0.09214	0.52387	0.59259	0.512	0.114

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.02649c			4.53394c		4.16639c	4.67384c		
				0.74799	0.2332		0.98119				
Dates			88061124	88041824	88041824	88061124	88041824	88061124	88061124		

Scenario 7AM | Year 89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.19546	0.02983	0.01041	0.22529	0.04024	0.20587	0.2357	0.216	0.028
R2	79550	1465700	0.49238	0.0803	0.02826	0.57268	0.10856	0.52064	0.60094	0.547	0.077
R3	79550	1466300	0.41797	0.06399	0.02198	0.48196	0.08597	0.43995	0.50394	0.461	0.061
R4	78000	1465000	0.107	0.01919	0.00565	0.12619	0.02484	0.11265	0.13184	0.119	0.018
R5	80000	1465000	0.1997	0.03667	0.01043	0.23637	0.0471	0.21013	0.2468	0.223	0.033
R6	80000	1467000	0.16552	0.02818	0.00807	0.1937	0.03625	0.17359	0.20177	0.184	0.026
R7	78000	1467000	0.17886	0.03075	0.00888	0.20961	0.03963	0.18774	0.21849	0.199	0.028

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	4.07785	0.79719	0.23602	4.87504	1.03321	4.31387	5.11106	4.594	0.731
R2	79550	1465700	4.59993	0.73579	0.26286	5.33572	0.99865	4.86279	5.59858	5.099	0.706
R3	79550	1466300	5.95239	0.79356	0.24131	6.74595	1.03487	6.1937	6.98726	6.470	0.732
R4	78000	1465000	2.43043	0.44299	0.14188	2.87342	0.58487	2.57231	3.0153	2.723	0.414
R5	80000	1465000	2.72534	0.51951	0.1449	3.24485	0.66441	2.87024	3.38975	3.058	0.470
R6	80000	1467000	1.88012	0.32882	0.09263	2.20894	0.42145	1.97275	2.30157	2.091	0.298
R7	78000	1467000	1.79474	0.29612	0.08705	2.09086	0.38317	1.88179	2.17791	1.986	0.271

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.49238	0.0803	0.02826	0.57268	0.10856	0.52064	0.60094	0.547	0.077
2nd Highest	79550	1466300	0.41797	0.06399	0.02198	0.48196	0.08597	0.43995	0.50394	0.461	0.061

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	5.95239c			6.74594c	1.03487c	6.19370c	6.98726c		
	79550	1465700			0.26286						
Dates	78400	1465800		.79719c							

Scenario 8 AM — Year 89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.19324	0.02917	0.01015	0.22241	0.03932	0.20339	0.23256	0.213	0.028
R2	79550	1465700	0.4838	0.07914	0.0278	0.56294	0.10694	0.5116	0.59074	0.537	0.076
R3	79550	1466300	0.38614	0.05916	0.02011	0.4453	0.07927	0.40625	0.46541	0.426	0.056
R4	78000	1465000	0.10659	0.01906	0.00565	0.12565	0.02471	0.11224	0.1313	0.119	0.017
R5	80000	1465000	0.19582	0.03655	0.01027	0.23237	0.04682	0.20609	0.24264	0.219	0.033
R6	80000	1467000	0.15083	0.02576	0.00736	0.17659	0.03312	0.15819	0.18395	0.167	0.023
R7	78000	1467000	0.1728	0.02983	0.00861	0.20263	0.03844	0.18141	0.21124	0.192	0.027

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	4.07785	0.79719	0.23602	4.87504	1.03321	4.31387	5.11106	4.594	0.731
R2	79550	1465700	4.59993	0.73579	0.26286	5.33572	0.99865	4.86279	5.59858	5.099	0.706
R3	79550	1466300	6.02644	0.78551	0.23485	6.81195	1.02036	6.26129	7.0468	6.537	0.722
R4	78000	1465000	2.60684	0.46901	0.15117	3.07585	0.62018	2.75801	3.22702	2.917	0.439
R5	80000	1465000	2.72534	0.51951	0.1449	3.24485	0.66441	2.87024	3.38975	3.058	0.470
R6	80000	1467000	1.92018	0.3232	0.09077	2.24338	0.41397	2.01095	2.33415	2.127	0.293
R7	78000	1467000	1.79474	0.29612	0.08705	2.09086	0.38317	1.88179	2.17791	1.986	0.271

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.4838	0.07914	0.0278	0.56294	0.10694	0.5116	0.59074	0.537	0.076
2nd Highest	79550	1466300	0.38614	0.05916	0.02011	0.4453	0.07927	0.40625	0.46541	0.426	0.056

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	6.02644c			6.81195c		6.26129c	7.04679c		
	79550	1465700			0.26286						
	78400	1465800		.79719c			1.03321c				
Dates			89080824	89091824	89050724	89080824	89091824	89080824	89080824		

Scenario 9AM **Year 89**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.17382	0.0266	0.00922	0.20042	0.03582	0.18304	0.20964	0.192	0.025
R2	79550	1465700	0.46974	0.07735	0.02715	0.54709	0.1045	0.49689	0.57424	0.522	0.074
R3	79550	1466300	0.3683	0.05577	0.01895	0.42407	0.07472	0.38725	0.44302	0.406	0.053
R4	78000	1465000	0.10419	0.0185	0.0055	0.12269	0.024	0.10969	0.12819	0.116	0.017
R5	80000	1465000	0.18657	0.03491	0.0098	0.22148	0.04471	0.19637	0.23128	0.209	0.032
R6	80000	1467000	0.14414	0.02479	0.00703	0.16893	0.03182	0.15117	0.17596	0.160	0.023
R7	78000	1467000	0.1744	0.03005	0.0087	0.20445	0.03875	0.1831	0.21315	0.194	0.027

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	4.07784	0.79719	0.23602	4.87503	1.03321	4.31386	5.11105	4.594	0.731
R2	79550	1465700	4.46105	0.69637	0.2485	5.15742	0.94487	4.70955	5.40592	4.933	0.668
R3	79550	1466300	5.11328	0.65298	0.21467	5.76626	0.86765	5.32795	5.98093	5.547	0.614
R4	78000	1465000	2.68477	0.47756	0.15311	3.16233	0.63067	2.83788	3.31544	3.000	0.446
R5	80000	1465000	2.72533	0.51951	0.1449	3.24484	0.66441	2.87023	3.38974	3.058	0.470
R6	80000	1467000	1.48639	0.25649	0.07297	1.74288	0.32946	1.55936	1.81585	1.651	0.233
R7	78000	1467000	1.79472	0.29612	0.08705	2.09084	0.38317	1.88177	2.17789	1.986	0.271

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.46974	0.07735	0.02715	0.54709	0.1045	0.49689	0.57424	0.522	0.074
2nd Highest	79550	1466300	0.3683	0.05577	0.01895	0.42407	0.07472	0.38725	0.44302	0.406	0.053

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	5.11328c			5.76626c		5.31153c	5.96451c		
	79550	1465700			0.2485						
	78400	1465800		.79719c			1.03320c				
Dates			89080824	89091824	89050724	89080824	89091824	89080824	89080824		

Scenario10 AM **Year89**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.16318	0.02466	0.00857	0.18784	0.03323	0.17175	0.19641	0.180	0.023
R2	79550	1465700	0.43839	0.0716	0.02542	0.50999	0.09702	0.46381	0.53541	0.487	0.069
R3	79550	1466300	0.34327	0.05191	0.01777	0.39518	0.06968	0.36104	0.41295	0.378	0.049
R4	78000	1465000	0.10232	0.01801	0.00541	0.12033	0.02342	0.10773	0.12574	0.114	0.017
R5	80000	1465000	0.18195	0.03386	0.00955	0.21581	0.04341	0.1915	0.22536	0.204	0.031
R6	80000	1467000	0.14228	0.0242	0.00695	0.16648	0.03115	0.14923	0.17343	0.158	0.022
R7	78000	1467000	0.17609	0.03017	0.00881	0.20626	0.03898	0.1849	0.21507	0.196	0.028

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	3.04965	0.616	0.18243	3.66565	0.79843	3.23208	3.84808	3.449	0.565
R2	79550	1465700	3.90968	0.71585	0.22067	4.62553	0.93652	4.13035	4.8462	4.378	0.662
R3	79550	1466300	4.70255	0.59946	0.21467	5.30201	0.81413	4.91722	5.51668	5.110	0.576
R4	78000	1465000	3.00551	0.52799	0.17199	3.5335	0.69998	3.1775	3.70549	3.356	0.495
R5	80000	1465000	2.59902	0.49309	0.13827	3.09211	0.63136	2.73729	3.23038	2.915	0.446
R6	80000	1467000	1.48639	0.22725	0.07297	1.71364	0.30022	1.55936	1.78661	1.637	0.212
R7	78000	1467000	1.65786	0.2593	0.08087	1.91716	0.34017	1.73873	1.99803	1.828	0.241

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.43839	0.0716	0.02542	0.50999	0.09702	0.46381	0.53541	0.487	0.069
2nd Highest	79550	1466300	0.34327	0.05191	0.01777	0.39518	0.06968	0.36104	0.41295	0.378	0.049

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.70255c			5.30202c		4.88845c	5.48791c		
	79550	1465700		0.71585	0.22067		0.93651				
Dates			89080824	89052724	89052724	89080824	89052724	89080824	89080824		

Scenario11 AM   Year89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.15036	0.02316	0.00814	0.17352	0.0313	0.1585	0.18166	0.166	0.022
R2	79550	1465700	0.41575	0.06721	0.02418	0.48296	0.09139	0.43993	0.50714	0.461	0.065
R3	79550	1466300	0.3291	0.04921	0.0171	0.37831	0.06631	0.3462	0.39541	0.362	0.047
R4	78000	1465000	0.1029	0.01806	0.00546	0.12096	0.02352	0.10836	0.12642	0.115	0.017
R5	80000	1465000	0.17475	0.03232	0.00917	0.20707	0.04149	0.18392	0.21624	0.195	0.029
R6	80000	1467000	0.14101	0.02371	0.00688	0.16472	0.03059	0.14789	0.1716	0.156	0.022
R7	78000	1467000	0.17327	0.02965	0.00868	0.20292	0.03833	0.18195	0.2116	0.192	0.027

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	3.04965	0.616	0.18243	3.66565	0.79843	3.23208	3.84808	3.449	0.565
R2	79550	1465700	3.64315	0.61522	0.19527	4.25837	0.81049	3.83842	4.45364	4.048	0.573
R3	79550	1466300	4.70255	0.59946	0.21467	5.30201	0.81413	4.91722	5.51668	5.110	0.576
R4	78000	1465000	3.37343	0.59801	0.1941	3.97144	0.79211	3.56753	4.16554	3.769	0.560
R5	80000	1465000	2.56987	0.48753	0.13672	3.0574	0.62425	2.70659	3.19412	2.882	0.441
R6	80000	1467000	1.4741	0.27235	0.07656	1.74645	0.34891	1.55066	1.82301	1.649	0.247
R7	78000	1467000	1.65786	0.25781	0.08087	1.91567	0.33868	1.73873	1.99654	1.827	0.239

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.41575	0.06721	0.02418	0.48296	0.09139	0.43993	0.50714	0.461	0.065
2nd Highest	79550	1466300	0.3291	0.04921	0.0171	0.37831	0.06631	0.3462	0.39541	0.362	0.047

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.70255c		.21467c	5.30202c		4.88845c	5.48791c		
	79550	1465700					0.80849				
	78400	1465800		.61600c							
Dates			89080824	89091824	89102524	89080824	89100224	89080824	89080824		

Scenario 12PM   Year 89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.13824	0.02108	0.0075	0.15932	0.02858	0.14574	0.16682	0.153	0.020
R2	79550	1465700	0.40791	0.06497	0.02364	0.47288	0.08861	0.43155	0.49652	0.452	0.063
R3	79550	1466300	0.3221	0.04662	0.01646	0.36872	0.06308	0.33856	0.38518	0.354	0.045
R4	78000	1465000	0.1078	0.01864	0.00568	0.12644	0.02432	0.11348	0.13212	0.120	0.017
R5	80000	1465000	0.1702	0.03118	0.00891	0.20138	0.04009	0.17911	0.21029	0.190	0.028
R6	80000	1467000	0.13603	0.02278	0.00664	0.15881	0.02942	0.14267	0.16545	0.151	0.021
R7	78000	1467000	0.17246	0.02926	0.00864	0.20172	0.0379	0.1811	0.21036	0.191	0.027

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.01203	0.4118	0.14987	2.42383	0.56167	2.1619	2.5737	2.293	0.397
R2	79550	1465700	3.65071	0.601	0.19622	4.25171	0.79722	3.84693	4.44793	4.049	0.564
R3	79550	1466300	4.70255	0.59946	0.21466	5.30201	0.81412	4.91721	5.51667	5.110	0.576
R4	78000	1465000	3.52122	0.61121	0.20149	4.13243	0.8127	3.72271	4.33392	3.928	0.575
R5	80000	1465000	2.47731	0.4671	0.13178	2.94441	0.59888	2.60909	3.07619	2.777	0.423
R6	80000	1467000	1.46916	0.27121	0.07616	1.74037	0.34737	1.54532	1.81653	1.643	0.246
R7	78000	1467000	1.6607	0.25781	0.08099	1.91851	0.3388	1.74169	1.9995	1.830	0.240

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.40791	0.06497	0.02364	0.47288	0.08861	0.43155	0.49652	0.452	0.063
2nd Highest	79550	1466300	0.3221	0.04662	0.01646	0.36872	0.06308	0.33856	0.38518	0.354	0.045

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.70255c		.21466c	5.30202c		4.88845c	5.48791c		
	78000	1465000		0.61121			0.8127				
Dates			89080824	89121424	89102524	89080824	89121424	89080824	89080824		

Scenario 1PM **Year 89**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.1241	0.01837	0.0066	0.14247	0.02497	0.1307	0.14907	0.137	0.018
R2	79550	1465700	0.40686	0.06385	0.0235	0.47071	0.08735	0.43036	0.49421	0.451	0.062
R3	79550	1466300	0.30742	0.04396	0.01573	0.35138	0.05969	0.32315	0.36711	0.337	0.042
R4	78000	1465000	0.11078	0.01918	0.00586	0.12996	0.02504	0.11664	0.13582	0.123	0.018
R5	80000	1465000	0.17196	0.03119	0.00899	0.20315	0.04018	0.18095	0.21214	0.192	0.028
R6	80000	1467000	0.13888	0.02309	0.00679	0.16197	0.02988	0.14567	0.16876	0.154	0.021
R7	78000	1467000	0.16731	0.02831	0.0084	0.19562	0.03671	0.17571	0.20402	0.186	0.026

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	1.98018	0.41146	0.13518	2.39164	0.54664	2.11536	2.52682	2.254	0.387
R2	79550	1465700	4.11416	0.59831	0.21032	4.71247	0.80863	4.32448	4.92279	4.518	0.572
R3	79550	1466300	4.04713	0.55174	0.18913	4.59887	0.74087	4.23626	4.788	4.418	0.524
R4	78000	1465000	3.52123	0.61122	0.20149	4.13245	0.81271	3.72272	4.33394	3.928	0.575
R5	80000	1465000	2.19072	0.40697	0.11654	2.59769	0.52351	2.30726	2.71423	2.452	0.370
R6	80000	1467000	1.5385	0.26823	0.07514	1.80673	0.34337	1.61364	1.88187	1.710	0.243
R7	78000	1467000	1.51111	0.25697	0.07463	1.76808	0.3316	1.58574	1.84271	1.677	0.234

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.40686	0.06385	0.0235	0.47071	0.08735	0.43036	0.49421	0.451	0.062
2nd Highest	79550	1466300	0.30742	0.04396	0.01573	0.35138	0.05969	0.32315	0.36711	0.337	0.042

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.11416		0.21032	4.67566		4.32447	4.88598		
	78000	1465000		0.61122			0.8127				
Dates			89050724	89121424	89050724	89050724	89121424	89050724	89050724		

Scenario 2PM Year89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.11397	0.01626	0.00594	0.13023	0.0222	0.11991	0.13617	0.125	0.016
R2	79550	1465700	0.39698	0.06112	0.02278	0.4581	0.0839	0.41976	0.48088	0.439	0.059
R3	79550	1466300	0.28596	0.04007	0.01467	0.32603	0.05474	0.30063	0.3407	0.313	0.039
R4	78000	1465000	0.10835	0.01835	0.00563	0.1267	0.02398	0.11398	0.13233	0.120	0.017
R5	80000	1465000	0.16734	0.03028	0.00875	0.19762	0.03903	0.17609	0.20637	0.187	0.028
R6	80000	1467000	0.14507	0.0236	0.007	0.16867	0.0306	0.15207	0.17567	0.160	0.022
R7	78000	1467000	0.17126	0.02872	0.00859	0.19998	0.03731	0.17985	0.20857	0.190	0.026

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	1.98018	0.36984	0.13518	2.35002	0.50502	2.11536	2.4852	2.233	0.357
R2	79550	1465700	3.94111	0.53576	0.19341	4.47687	0.72917	4.13452	4.67028	4.306	0.516
R3	79550	1466300	4.04521	0.51211	0.17817	4.55732	0.69028	4.22338	4.73549	4.390	0.488
R4	78000	1465000	3.50495	0.60542	0.19939	4.11037	0.80481	3.70434	4.30976	3.907	0.569
R5	80000	1465000	1.78656	0.32755	0.09509	2.11411	0.42264	1.88165	2.2092	1.998	0.299
R6	80000	1467000	1.53878	0.24403	0.07297	1.78281	0.317	1.61175	1.85578	1.697	0.224
R7	78000	1467000	1.77027	0.28611	0.08984	2.05638	0.37595	1.86011	2.14622	1.958	0.266

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.39698	0.06112	0.02278	0.4581	0.0839	0.41976	0.48088	0.439	0.059
2nd Highest	79550	1466300	0.28596	0.04007	0.01467	0.32603	0.05474	0.30063	0.3407	0.313	0.039

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.04521c			4.51175c		4.19448c	4.66101c		
	78000	1465000		0.60542	0.19939		0.80481				
Dates			89080824	89121424	89121424	89080824	89121424	89080824	89080824		

Scenario 3PM **Year 89**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.10268	0.01402	0.00524	0.1167	0.01926	0.10792	0.12194	0.112	0.014
R2	79550	1465700	0.39001	0.05928	0.02234	0.44929	0.08162	0.41235	0.47163	0.431	0.058
R3	79550	1466300	0.28353	0.03838	0.01429	0.32191	0.05267	0.29782	0.3362	0.310	0.037
R4	78000	1465000	0.11266	0.01886	0.00579	0.13152	0.02465	0.11845	0.13731	0.125	0.017
R5	80000	1465000	0.17355	0.03082	0.00903	0.20437	0.03985	0.18258	0.2134	0.193	0.028
R6	80000	1467000	0.15106	0.0244	0.00732	0.17546	0.03172	0.15838	0.18278	0.167	0.022
R7	78000	1467000	0.18044	0.02991	0.00904	0.21035	0.03895	0.18948	0.21939	0.200	0.028

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.17907	0.30245	0.11265	2.48152	0.4151	2.29172	2.59417	2.387	0.294
R2	79550	1465700	3.94093	0.59405	0.19637	4.53498	0.79042	4.1373	4.73135	4.336	0.559
R3	79550	1466300	3.82825	0.49093	0.16919	4.31918	0.66012	3.99744	4.48837	4.158	0.467
R4	78000	1465000	3.48155	0.59501	0.19567	4.07656	0.79068	3.67722	4.27223	3.877	0.559
R5	80000	1465000	1.78559	0.32733	0.09504	2.11292	0.42237	1.88063	2.20796	1.997	0.299
R6	80000	1467000	1.53878	0.25936	0.07297	1.79814	0.33233	1.61175	1.87111	1.705	0.235
R7	78000	1467000	2.18909	0.35737	0.10739	2.54646	0.46476	2.29648	2.65385	2.421	0.329

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.39001	0.05928	0.02234	0.44929	0.08162	0.41235	0.47163	0.431	0.058
2nd Highest	79550	1466300	0.28353	0.03838	0.01429	0.32191	0.05267	0.29782	0.3362	0.310	0.037

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	3.94093		0.19637	4.45181		4.13434	4.64522		
	78000	1465000		0.59501			0.79068				
Dates			89050724	89121424	89080624	89050724	89121424	89050724	89050724		

Scenario 4PM Year 89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.09431	0.01285	0.00498	0.10716	0.01783	0.09929	0.11214	0.103	0.013
R2	79550	1465700	0.39029	0.05861	0.02227	0.4489	0.08088	0.41256	0.47117	0.431	0.057
R3	79550	1466300	0.29821	0.04052	0.01533	0.33873	0.05585	0.31354	0.35406	0.326	0.039
R4	78000	1465000	0.11195	0.01869	0.00574	0.13064	0.02443	0.11769	0.13638	0.124	0.017
R5	80000	1465000	0.17735	0.03081	0.00919	0.20816	0.04	0.18654	0.21735	0.197	0.028
R6	80000	1467000	0.16564	0.02671	0.00801	0.19235	0.03472	0.17365	0.20036	0.183	0.025
R7	78000	1467000	0.18461	0.03037	0.00922	0.21498	0.03959	0.19383	0.2242	0.204	0.028

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.17907	0.30245	0.11265	2.48152	0.4151	2.29172	2.59417	2.387	0.294
R2	79550	1465700	3.45177	0.59428	0.19645	4.04605	0.79073	3.64822	4.2425	3.847	0.559
R3	79550	1466300	3.10448	0.44952	0.16106	3.554	0.61058	3.26554	3.71506	3.410	0.432
R4	78000	1465000	3.131	0.55562	0.18574	3.68662	0.74136	3.31674	3.87236	3.502	0.524
R5	80000	1465000	1.78559	0.32733	0.09504	2.11292	0.42237	1.88063	2.20796	1.997	0.299
R6	80000	1467000	1.53878	0.25936	0.07297	1.79814	0.33233	1.61175	1.87111	1.705	0.235
R7	78000	1467000	2.18909	0.35737	0.10739	2.54646	0.46476	2.29648	2.65385	2.421	0.329

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.39029	0.05861	0.02227	0.4489	0.08088	0.41256	0.47117	0.431	0.057
2nd Highest	79550	1466300	0.29821	0.04052	0.01533	0.33873	0.05585	0.31354	0.35406	0.326	0.039

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	3.45177	0.59428	0.19645	3.90187	0.79073	3.62151	4.07161		
Dates			89050724	89080624	89080624	89050724	89080624	89050724	89050724		

Scenario 5PM Year 89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.10092	0.01351	0.00511	0.11443	0.01862	0.10603	0.11954	0.110	0.013
R2	79550	1465700	0.39505	0.0581	0.02212	0.45315	0.08022	0.41717	0.47527	0.435	0.057
R3	79550	1466300	0.30897	0.04273	0.01621	0.3517	0.05894	0.32518	0.36791	0.338	0.042
R4	78000	1465000	0.10805	0.01779	0.00543	0.12584	0.02322	0.11348	0.13127	0.120	0.016
R5	80000	1465000	0.17773	0.03083	0.00919	0.20856	0.04002	0.18692	0.21775	0.198	0.028
R6	80000	1467000	0.17942	0.02844	0.0086	0.20786	0.03704	0.18802	0.21646	0.198	0.026
R7	78000	1467000	0.18291	0.03003	0.00912	0.21294	0.03915	0.19203	0.22206	0.202	0.028

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.17907	0.30245	0.11265	2.48152	0.4151	2.29172	2.59417	2.387	0.294
R2	79550	1465700	3.29955	0.59428	0.19645	3.89383	0.79073	3.496	4.09028	3.695	0.559
R3	79550	1466300	2.92227	0.48859	0.17059	3.41086	0.65918	3.09286	3.58145	3.252	0.466
R4	78000	1465000	3.13236	0.55631	0.18601	3.68867	0.74232	3.31837	3.87468	3.504	0.525
R5	80000	1465000	1.42161	0.24353	0.07389	1.66514	0.31742	1.4955	1.73903	1.580	0.224
R6	80000	1467000	1.71611	0.25936	0.0736	1.97547	0.33296	1.78971	2.04907	1.883	0.235
R7	78000	1467000	2.18909	0.35737	0.10739	2.54646	0.46476	2.29648	2.65385	2.421	0.329

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.39505	0.0581	0.02212	0.45315	0.08022	0.41717	0.47527	0.435	0.057
2nd Highest	79550	1466300	0.30897	0.04273	0.01621	0.3517	0.05894	0.32518	0.36791	0.338	0.042

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	3.29955	0.59428	0.19645	3.75668	0.79073	3.47167	3.9288		
Dates			89050724	89080624	89080624	89050724	89080624	89050724	89050724		

Scenario 6PM **Year 89**

Annual Average Concentrations in ug/m^3

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
R1	78400	1465800	0.10105	0.01393	0.00519	0.11498	0.01912	0.10624	0.12017	0.111	0.014
R2	79550	1465700	0.42064	0.06205	0.0234	0.48269	0.08545	0.44404	0.50609	0.463	0.060
R3	79550	1466300	0.32923	0.04591	0.01721	0.37514	0.06312	0.34644	0.39235	0.361	0.045
R4	78000	1465000	0.09787	0.01626	0.00493	0.11413	0.02119	0.1028	0.11906	0.108	0.015
R5	80000	1465000	0.17465	0.03036	0.00903	0.20501	0.03939	0.18368	0.21404	0.194	0.028
R6	80000	1467000	0.18234	0.02925	0.00883	0.21159	0.03808	0.19117	0.22042	0.201	0.027
R7	78000	1467000	0.1674	0.02739	0.00833	0.19479	0.03572	0.17573	0.20312	0.185	0.025

First Highest Concentrations in ug/m^3

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
R1	78400	1465800	2.17907	0.35074	0.11341	2.52981	0.46415	2.29248	2.64322	2.411	0.328
R2	79550	1465700	3.86587	0.59428	0.20324	4.46015	0.79752	4.06911	4.66339	4.265	0.564
R3	79550	1466300	3.33298	0.54211	0.18506	3.87509	0.72717	3.51804	4.06015	3.697	0.514
R4	78000	1465000	2.63373	0.50042	0.16792	3.13415	0.66834	2.80165	3.30207	2.968	0.473
R5	80000	1465000	1.77403	0.32453	0.09354	2.09856	0.41807	1.86757	2.1921	1.983	0.296
R6	80000	1467000	1.7161	0.25936	0.07276	1.97546	0.33212	1.78886	2.04822	1.882	0.235
R7	78000	1467000	2.18909	0.35737	0.10739	2.54646	0.46476	2.29648	2.65385	2.421	0.329

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
1st Highest	79550	1465700	0.42064	0.06205	0.0234	0.48269	0.08545	0.44404	0.50609	0.463	0.060
2nd Highest	79550	1466300	0.32923	0.04591	0.01721	0.37514	0.06312	0.34644	0.39235	0.361	0.045

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
1st Highest	79550	1465700	3.86587	0.59428	0.20324	4.4095	0.79073	4.06911	4.61274		
Dates			89050724	89080624	89050724	89050724	89080624	89050724	89050724		

Scenario 7PM Year 89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.10557	0.01432	0.00516	0.11989	0.01948	0.11073	0.12505	0.115	0.014
R2	79550	1465700	0.42733	0.06443	0.02393	0.49176	0.08836	0.45126	0.51569	0.472	0.062
R3	79550	1466300	0.34141	0.04897	0.01819	0.39038	0.06716	0.3596	0.40857	0.375	0.047
R4	78000	1465000	0.09359	0.01555	0.00467	0.10914	0.02022	0.09826	0.11381	0.104	0.014
R5	80000	1465000	0.17706	0.03093	0.00916	0.20799	0.04009	0.18622	0.21715	0.197	0.028
R6	80000	1467000	0.18888	0.03041	0.00913	0.21929	0.03954	0.19801	0.22842	0.209	0.028
R7	78000	1467000	0.15407	0.02519	0.00766	0.17926	0.03285	0.16173	0.18692	0.170	0.023

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.26333	0.42953	0.14837	2.69286	0.5779	2.4117	2.84123	2.552	0.409
R2	79550	1465700	3.65549	0.59428	0.204	4.24977	0.79828	3.85949	4.45377	4.055	0.564
R3	79550	1466300	3.35564	0.66984	0.2379	4.02548	0.90774	3.59354	4.26338	3.810	0.642
R4	78000	1465000	2.30613	0.4369	0.14624	2.74303	0.58314	2.45237	2.88927	2.598	0.412
R5	80000	1465000	2.22592	0.40776	0.1173	2.63368	0.52506	2.34322	2.75098	2.488	0.371
R6	80000	1467000	1.78769	0.25936	0.07978	2.04705	0.33914	1.86747	2.12683	1.957	0.240
R7	78000	1467000	2.19759	0.35885	0.10784	2.55644	0.46669	2.30543	2.66428	2.431	0.330

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.42733	0.06443	0.02393	0.49176	0.08836	0.45126	0.51569	0.472	0.062
2nd Highest	79550	1466300	0.34141	0.04897	0.01819	0.39038	0.06716	0.3596	0.40857	0.375	0.047

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300		.66984c	.23790c		.90775c				
	79550	1465700	3.65549			4.21544		3.85949	4.41944		
Dates			89050724	89101324	89101324	89050724	89101324	89050724	89050724		

Scenario 8PM | Year 89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.11228	0.01594	0.00564	0.12822	0.02158	0.11792	0.13386	0.123	0.015
R2	79550	1465700	0.42768	0.06555	0.02415	0.49323	0.0897	0.45183	0.51738	0.473	0.063
R3	79550	1466300	0.35127	0.05165	0.0189	0.40292	0.07055	0.37017	0.42182	0.387	0.050
R4	78000	1465000	0.09281	0.01538	0.00453	0.10819	0.01991	0.09734	0.11272	0.103	0.014
R5	80000	1465000	0.1848	0.03249	0.00956	0.21729	0.04205	0.19436	0.22685	0.206	0.030
R6	80000	1467000	0.19565	0.03163	0.00945	0.22728	0.04108	0.2051	0.23673	0.216	0.029
R7	78000	1467000	0.1409	0.02319	0.00696	0.16409	0.03015	0.14786	0.17105	0.156	0.021

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.39966	0.42953	0.14837	2.82919	0.5779	2.54803	2.97756	2.689	0.409
R2	79550	1465700	3.4365	0.55437	0.19554	3.99087	0.74991	3.63204	4.18641	3.811	0.530
R3	79550	1466300	3.99448	0.74032	0.25541	4.7348	0.99573	4.24989	4.99021	4.492	0.704
R4	78000	1465000	2.28704	0.43456	0.14125	2.7216	0.57581	2.42829	2.86285	2.575	0.407
R5	80000	1465000	2.22592	0.40776	0.1173	2.63368	0.52506	2.34322	2.75098	2.488	0.371
R6	80000	1467000	2.01046	0.26268	0.0859	2.27314	0.34858	2.09636	2.35904	2.185	0.246
R7	78000	1467000	2.06082	0.33378	0.10085	2.3946	0.43463	2.16167	2.49545	2.278	0.307

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.42768	0.06555	0.02415	0.49323	0.0897	0.45183	0.51738	0.473	0.063
2nd Highest	79550	1466300	0.35127	0.05165	0.0189	0.40292	0.07055	0.37017	0.42182	0.387	0.050

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	3.99448c	.74032c	.25541c	4.73480c	.99573c	4.24989c	4.99021c		
Dates			89101324	89101324	89101324	89101324	89101324	89101324	89101324		

Scenario 9PM   Year 89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.12862	0.01892	0.00667	0.14754	0.02559	0.13529	0.15421	0.141	0.018
R2	79550	1465700	0.42691	0.06616	0.0241	0.49307	0.09026	0.45101	0.51717	0.472	0.064
R3	79550	1466300	0.35911	0.05278	0.01907	0.41189	0.07185	0.37818	0.43096	0.395	0.051
R4	78000	1465000	0.09244	0.01561	0.00459	0.10805	0.0202	0.09703	0.11264	0.103	0.014
R5	80000	1465000	0.18376	0.03258	0.00951	0.21634	0.04209	0.19327	0.22585	0.205	0.030
R6	80000	1467000	0.1991	0.03243	0.00965	0.23153	0.04208	0.20875	0.24118	0.220	0.030
R7	78000	1467000	0.13573	0.02242	0.00669	0.15815	0.02911	0.14242	0.16484	0.150	0.021

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.4	0.42953	0.14837	2.82953	0.5779	2.54837	2.9779	2.689	0.409
R2	79550	1465700	3.58876	0.54281	0.20065	4.13157	0.74346	3.78941	4.33222	3.960	0.526
R3	79550	1466300	3.99448	0.74032	0.25541	4.7348	0.99573	4.24989	4.99021	4.492	0.704
R4	78000	1465000	2.28631	0.43419	0.14108	2.7205	0.57527	2.42739	2.86158	2.574	0.407
R5	80000	1465000	2.22592	0.40776	0.1173	2.63368	0.52506	2.34322	2.75098	2.488	0.371
R6	80000	1467000	1.76997	0.3006	0.08266	2.07057	0.38326	1.85263	2.15323	1.962	0.271
R7	78000	1467000	2.06363	0.33435	0.10095	2.39798	0.4353	2.16458	2.49893	2.281	0.308

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.42691	0.06616	0.0241	0.49307	0.09026	0.45101	0.51717	0.472	0.064
2nd Highest	79550	1466300	0.35911	0.05278	0.01907	0.41189	0.07185	0.37818	0.43096	0.395	0.051

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	3.99448c	.74032c	.25541c	4.73480c	.99573c	4.24989c	4.99021c		
Dates			89101324	89101324	89101324	89101324	89101324	89101324	89101324		

Scenario 10PM Year 89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.13848	0.021	0.00732	0.15948	0.02832	0.1458	0.1668	0.153	0.020
R2	79550	1465700	0.43156	0.06833	0.02454	0.49989	0.09287	0.4561	0.52443	0.478	0.066
R3	79550	1466300	0.37861	0.05613	0.01984	0.43474	0.07597	0.39845	0.45458	0.417	0.054
R4	78000	1465000	0.09373	0.0161	0.0047	0.10983	0.0208	0.09843	0.11453	0.104	0.015
R5	80000	1465000	0.18415	0.03269	0.00952	0.21684	0.04221	0.19367	0.22636	0.205	0.030
R6	80000	1467000	0.19902	0.03257	0.00965	0.23159	0.04222	0.20867	0.24124	0.220	0.030
R7	78000	1467000	0.1313	0.02178	0.00644	0.15308	0.02822	0.13774	0.15952	0.145	0.020

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.59925	0.45429	0.14837	3.05354	0.60266	2.74762	3.20191	2.901	0.426
R2	79550	1465700	3.32243	0.54487	0.19286	3.8673	0.73773	3.51529	4.06016	3.691	0.522
R3	79550	1466300	4.77811	0.81432	0.27366	5.59243	1.08798	5.05177	5.86609	5.322	0.769
R4	78000	1465000	2.00243	0.37799	0.12323	2.38042	0.50122	2.12566	2.50365	2.253	0.354
R5	80000	1465000	2.22592	0.40776	0.1173	2.63368	0.52506	2.34322	2.75098	2.488	0.371
R6	80000	1467000	1.76997	0.31694	0.08872	2.08691	0.40566	1.85869	2.17563	1.973	0.287
R7	78000	1467000	1.83394	0.29918	0.0903	2.13312	0.38948	1.92424	2.22342	2.029	0.275

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.43156	0.06833	0.02454	0.49989	0.09287	0.4561	0.52443	0.478	0.066
2nd Highest	79550	1466300	0.37861	0.05613	0.01984	0.43474	0.07597	0.39845	0.45458	0.417	0.054

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.77811c	.81432c	.27366c	5.59243c	1.08798c	5.05178c	5.86610c		
Dates			89101324	89101324	89101324	89101324	89101324	89101324	89101324		

Scenario 11PM Year 89

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.15055	0.02375	0.00816	0.1743	0.03191	0.15871	0.18246	0.167	0.023
R2	79550	1465700	0.43269	0.06937	0.02472	0.50206	0.09409	0.45741	0.52678	0.480	0.067
R3	79550	1466300	0.39972	0.06013	0.02112	0.45985	0.08125	0.42084	0.48097	0.440	0.057
R4	78000	1465000	0.09753	0.0168	0.00487	0.11433	0.02167	0.1024	0.1192	0.108	0.015
R5	80000	1465000	0.1819	0.03238	0.00941	0.21428	0.04179	0.19131	0.22369	0.203	0.030
R6	80000	1467000	0.20065	0.03303	0.00976	0.23368	0.04279	0.21041	0.24344	0.222	0.030
R7	78000	1467000	0.12936	0.02162	0.00632	0.15098	0.02794	0.13568	0.1573	0.143	0.020

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	3.26185	0.60744	0.17608	3.86929	0.78352	3.43793	4.04537	3.654	0.554
R2	79550	1465700	3.43384	0.64273	0.20206	4.07657	0.84479	3.6359	4.27863	3.856	0.597
R3	79550	1466300	4.77811	0.81432	0.27366	5.59243	1.08798	5.05177	5.86609	5.322	0.769
R4	78000	1465000	2.03429	0.38897	0.12706	2.42326	0.51603	2.16135	2.55032	2.292	0.365
R5	80000	1465000	2.22592	0.40776	0.1173	2.63368	0.52506	2.34322	2.75098	2.488	0.371
R6	80000	1467000	2.0019	0.4035	0.11264	2.4054	0.51614	2.11454	2.51804	2.260	0.365
R7	78000	1467000	1.83394	0.29918	0.0903	2.13312	0.38948	1.92424	2.22342	2.029	0.275

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.43269	0.06937	0.02472	0.50206	0.09409	0.45741	0.52678	0.480	0.067
2nd Highest	79550	1466300	0.39972	0.06013	0.02112	0.45985	0.08125	0.42084	0.48097	0.440	0.057

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.77811c	.81432c	.27366c	5.59243c	1.08798c	5.05178c	5.86610c		
Dates			89101324	89101324	89101324	89101324	89101324	89101324	89101324		

Scenario 7AM	Year 90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.16893	0.027	0.00926	0.19593	0.03626	0.17819	0.20519	0.187	0.026
R2	79550	1465700	0.44071	0.07455	0.0258	0.51526	0.10035	0.46651	0.54106	0.491	0.071
R3	79550	1466300	0.3887	0.06879	0.02273	0.45749	0.09152	0.41143	0.48022	0.434	0.065
R4	78000	1465000	0.10139	0.0175	0.0049	0.11889	0.0224	0.10629	0.12379	0.113	0.016
R5	80000	1465000	0.19636	0.03678	0.01029	0.23314	0.04707	0.20665	0.24343	0.220	0.033
R6	80000	1467000	0.18149	0.03191	0.00896	0.2134	0.04087	0.19045	0.22236	0.202	0.029
R7	78000	1467000	0.17347	0.02949	0.00854	0.20296	0.03803	0.18201	0.2115	0.192	0.027

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	4.11192	0.64147	0.20785	4.75339	0.84932	4.31977	4.96124	4.537	0.601
R2	79550	1465700	4.46196	0.8612	0.27247	5.32316	1.13367	4.73443	5.59563	5.029	0.802
R3	79550	1466300	3.48477	0.65395	0.20275	4.13872	0.8567	3.68752	4.34147	3.913	0.606
R4	78000	1465000	2.15292	0.33292	0.10342	2.48584	0.43634	2.25634	2.58926	2.371	0.309
R5	80000	1465000	1.89389	0.36098	0.10033	2.25487	0.46131	1.99422	2.3552	2.125	0.326
R6	80000	1467000	2.24056	0.43222	0.12468	2.67278	0.5569	2.36524	2.79746	2.519	0.394
R7	78000	1467000	1.97654	0.33616	0.09904	2.3127	0.4352	2.07558	2.41174	2.194	0.308

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.44071	0.07455	0.0258	0.51526	0.10035	0.46651	0.54106	0.491	0.071
2nd Highest	79550	1466300	0.3887	0.06879	0.02273	0.45749	0.09152	0.41143	0.48022	0.434	0.065

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.46196c	.86120c	.27247c	5.32316c	1.13367c	4.73443c	5.59564c		
Dates			90091424	90091424	90091424	90091424	90091424	90091424	90091424		

Scenario 8 AM Year 90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.16453	0.02619	0.00895	0.19072	0.03514	0.17348	0.19967	0.182	0.025
R2	79550	1465700	0.43291	0.07306	0.02534	0.50597	0.0984	0.45825	0.53131	0.482	0.070
R3	79550	1466300	0.36315	0.06479	0.02122	0.42794	0.08601	0.38437	0.44916	0.406	0.061
R4	78000	1465000	0.1007	0.0172	0.00483	0.1179	0.02203	0.10553	0.12273	0.112	0.016
R5	80000	1465000	0.18811	0.03529	0.00986	0.2234	0.04515	0.19797	0.23326	0.211	0.032
R6	80000	1467000	0.16454	0.02919	0.00816	0.19373	0.03735	0.1727	0.20189	0.183	0.026
R7	78000	1467000	0.17754	0.03008	0.00875	0.20762	0.03883	0.18629	0.21637	0.197	0.027

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	4.11192	0.64147	0.20785	4.75339	0.84932	4.31977	4.96124	4.537	0.601
R2	79550	1465700	4.46196	0.8612	0.27247	5.32316	1.13367	4.73443	5.59563	5.029	0.802
R3	79550	1466300	3.0602	0.64165	0.20275	3.70185	0.8444	3.26295	3.9046	3.482	0.597
R4	78000	1465000	1.69107	0.31912	0.08652	2.01019	0.40564	1.77759	2.09671	1.894	0.287
R5	80000	1465000	1.85793	0.37215	0.0984	2.23008	0.47055	1.95633	2.32848	2.093	0.333
R6	80000	1467000	1.95244	0.35841	0.10343	2.31085	0.46184	2.05587	2.41428	2.183	0.327
R7	78000	1467000	1.98206	0.33616	0.09904	2.31822	0.4352	2.0811	2.41726	2.200	0.308

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.43291	0.07306	0.02534	0.50597	0.0984	0.45825	0.53131	0.482	0.070
2nd Highest	79550	1466300	0.36315	0.06479	0.02122	0.42794	0.08601	0.38437	0.44916	0.406	0.061

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.46196c	.86120c	.27247c	5.32316c	1.13367c	4.73443c	5.59564c		
Dates			90091424	90091424	90091424	90091424	90091424	90091424	90091424		

Scenario 9AM Year 90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.15806	0.02498	0.0085	0.18304	0.03348	0.16656	0.19154	0.175	0.024
R2	79550	1465700	0.42483	0.07229	0.02502	0.49712	0.09731	0.44985	0.52214	0.473	0.069
R3	79550	1466300	0.3338	0.06071	0.01997	0.39451	0.08068	0.35377	0.41448	0.374	0.057
R4	78000	1465000	0.09791	0.01678	0.00473	0.11469	0.02151	0.10264	0.11942	0.109	0.015
R5	80000	1465000	0.19047	0.03557	0.00999	0.22604	0.04556	0.20046	0.23603	0.213	0.032
R6	80000	1467000	0.1489	0.02635	0.00733	0.17525	0.03368	0.15623	0.18258	0.166	0.024
R7	78000	1467000	0.17606	0.02974	0.00869	0.2058	0.03843	0.18475	0.21449	0.195	0.027

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	4.10678	0.64139	0.20784	4.74817	0.84923	4.31462	4.95601	4.531	0.600
R2	79550	1465700	4.46196	0.8612	0.27247	5.32316	1.13367	4.73443	5.59563	5.029	0.802
R3	79550	1466300	3.0602	0.64165	0.20269	3.70185	0.84434	3.26289	3.90454	3.482	0.597
R4	78000	1465000	1.69107	0.31912	0.08652	2.01019	0.40564	1.77759	2.09671	1.894	0.287
R5	80000	1465000	1.82995	0.36577	0.09691	2.19572	0.46268	1.92686	2.29263	2.061	0.327
R6	80000	1467000	1.78838	0.30872	0.08742	2.0971	0.39614	1.8758	2.18452	1.986	0.280
R7	78000	1467000	1.96461	0.3359	0.09802	2.30051	0.43392	2.06263	2.39853	2.182	0.307

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.42483	0.07229	0.02502	0.49712	0.09731	0.44985	0.52214	0.473	0.069
2nd Highest	79550	1466300	0.3338	0.06071	0.01997	0.39451	0.08068	0.35377	0.41448	0.374	0.057

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.46196c	.86120c	.27247c	5.32316c	1.13367c	4.73443c	5.59564c		
Dates			90091424	90091424	90091424	90091424	90091424	90091424	90091424		

Scenario10 AM **Year90**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.14828	0.0241	0.00827	0.17238	0.03237	0.15655	0.18065	0.164	0.023
R2	79550	1465700	0.42224	0.07185	0.02501	0.49409	0.09686	0.44725	0.5191	0.471	0.068
R3	79550	1466300	0.29579	0.05354	0.01762	0.34933	0.07116	0.31341	0.36695	0.331	0.050
R4	78000	1465000	0.09657	0.01649	0.00465	0.11306	0.02114	0.10122	0.11771	0.107	0.015
R5	80000	1465000	0.18416	0.03431	0.00965	0.21847	0.04396	0.19381	0.22812	0.206	0.031
R6	80000	1467000	0.14898	0.02608	0.00731	0.17506	0.03339	0.15629	0.18237	0.166	0.024
R7	78000	1467000	0.17236	0.02899	0.00854	0.20135	0.03753	0.1809	0.20989	0.191	0.027

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	3.95405	0.63572	0.20656	4.58977	0.84228	4.16061	4.79633	4.375	0.596
R2	79550	1465700	4.46196	0.8612	0.27247	5.32316	1.13367	4.73443	5.59563	5.029	0.802
R3	79550	1466300	3.0602	0.64165	0.18349	3.70185	0.82514	3.24369	3.88534	3.473	0.583
R4	78000	1465000	1.69107	0.31912	0.08652	2.01019	0.40564	1.77759	2.09671	1.894	0.287
R5	80000	1465000	1.76599	0.3143	0.09197	2.08029	0.40627	1.85796	2.17226	1.969	0.287
R6	80000	1467000	1.8406	0.30872	0.08742	2.14932	0.39614	1.92802	2.23674	2.039	0.280
R7	78000	1467000	1.96461	0.3359	0.09802	2.30051	0.43392	2.06263	2.39853	2.182	0.307

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.42224	0.07185	0.02501	0.49409	0.09686	0.44725	0.5191	0.471	0.068
2nd Highest	79550	1466300	0.29579	0.05354	0.01762	0.34933	0.07116	0.31341	0.36695	0.331	0.050

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.46196c	.86120c	.27247c	5.32316c	1.13367c	4.73443c	5.59564c		
Dates			90091424	90091424	90091424	90091424	90091424	90091424	90091424		

Scenario11 AM Year90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.14339	0.02329	0.00807	0.16668	0.03136	0.15146	0.17475	0.159	0.022
R2	79550	1465700	0.4121	0.06948	0.02422	0.48158	0.0937	0.43632	0.5058	0.459	0.066
R3	79550	1466300	0.27195	0.04919	0.01626	0.32114	0.06545	0.28821	0.3374	0.305	0.046
R4	78000	1465000	0.09417	0.01613	0.00457	0.1103	0.0207	0.09874	0.11487	0.105	0.015
R5	80000	1465000	0.17558	0.03257	0.0092	0.20815	0.04177	0.18478	0.21735	0.196	0.030
R6	80000	1467000	0.14567	0.0253	0.00716	0.17097	0.03246	0.15283	0.17813	0.162	0.023
R7	78000	1467000	0.17173	0.02895	0.00852	0.20068	0.03747	0.18025	0.2092	0.190	0.026

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	3.94228	0.6355	0.20652	4.57778	0.84202	4.1488	4.7843	4.363	0.595
R2	79550	1465700	4.46101	0.86074	0.2723	5.32175	1.13304	4.73331	5.59405	5.028	0.801
R3	79550	1466300	3.07472	0.64905	0.18788	3.72377	0.83693	3.2626	3.91165	3.493	0.592
R4	78000	1465000	1.69107	0.31912	0.08652	2.01019	0.40564	1.77759	2.09671	1.894	0.287
R5	80000	1465000	1.76889	0.31498	0.09212	2.08387	0.4071	1.86101	2.17599	1.972	0.288
R6	80000	1467000	1.7634	0.30721	0.08685	2.07061	0.39406	1.85025	2.15746	1.960	0.279
R7	78000	1467000	1.96461	0.3359	0.09802	2.30051	0.43392	2.06263	2.39853	2.182	0.307

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.4121	0.06948	0.02422	0.48158	0.0937	0.43632	0.5058	0.459	0.066
2nd Highest	79550	1466300	0.27195	0.04919	0.01626	0.32114	0.06545	0.28821	0.3374	0.305	0.046

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.46101c	.86074c	.27230c	5.32175c	1.13304c	4.73332c	5.59405c		
Dates			90091424	90091424	90091424	90091424	90091424	90091424	90091424		

Scenario 12PM Year90

Annual Average Concentrations in ug/m^3

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
R1	78400	1465800	0.14099	0.02239	0.00782	0.16338	0.03021	0.14881	0.1712	0.156	0.021
R2	79550	1465700	0.40587	0.06728	0.02374	0.47315	0.09102	0.42961	0.49689	0.451	0.064
R3	79550	1466300	0.25723	0.04495	0.01497	0.30218	0.05992	0.2722	0.31715	0.287	0.042
R4	78000	1465000	0.09534	0.01604	0.00455	0.11138	0.02059	0.09989	0.11593	0.106	0.015
R5	80000	1465000	0.17432	0.03245	0.00918	0.20677	0.04163	0.1835	0.21595	0.195	0.029
R6	80000	1467000	0.15058	0.02579	0.00739	0.17637	0.03318	0.15797	0.18376	0.167	0.023
R7	78000	1467000	0.16615	0.02806	0.00826	0.19421	0.03632	0.17441	0.20247	0.184	0.026

First Highest Concentrations in ug/m^3

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
R1	78400	1465800	3.66283	0.5183	0.16326	4.18113	0.68156	3.82609	4.34439	4.004	0.482
R2	79550	1465700	4.22027	0.84316	0.26534	5.06343	1.1085	4.48561	5.32877	4.775	0.784
R3	79550	1466300	2.72457	0.55614	0.17158	3.28071	0.72772	2.89615	3.45229	3.088	0.515
R4	78000	1465000	1.69107	0.31912	0.08652	2.01019	0.40564	1.77759	2.09671	1.894	0.287
R5	80000	1465000	1.76891	0.31499	0.09213	2.0839	0.40712	1.86104	2.17603	1.972	0.288
R6	80000	1467000	1.7634	0.30721	0.08685	2.07061	0.39406	1.85025	2.15746	1.960	0.279
R7	78000	1467000	1.96461	0.3359	0.09802	2.30051	0.43392	2.06263	2.39853	2.182	0.307

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.40587	0.06728	0.02374	0.47315	0.09102	0.42961	0.49689	0.451	0.064
2nd Highest	79550	1466300	0.25723	0.04495	0.01497	0.30218	0.05992	0.2722	0.31715	0.287	0.042

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.22027c	.84316c	.26534c	5.06343c	1.10850c	4.48561c	5.32877c		
Dates			90091424	90091424	90091424	90091424	90091424	90091424	90091424		

Scenario 1PM — Year 90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.13234	0.02054	0.00713	0.15288	0.02767	0.13947	0.16001	0.146	0.020
R2	79550	1465700	0.40648	0.06584	0.02353	0.47232	0.08937	0.43001	0.49585	0.451	0.063
R3	79550	1466300	0.23	0.03937	0.01338	0.26937	0.05275	0.24338	0.28275	0.256	0.037
R4	78000	1465000	0.09089	0.01534	0.00438	0.10623	0.01972	0.09527	0.11061	0.101	0.014
R5	80000	1465000	0.16641	0.0309	0.00877	0.19731	0.03967	0.17518	0.20608	0.186	0.028
R6	80000	1467000	0.15125	0.02595	0.00753	0.1772	0.03348	0.15878	0.18473	0.168	0.024
R7	78000	1467000	0.17057	0.02857	0.00848	0.19914	0.03705	0.17905	0.20762	0.189	0.026

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	3.46661	0.50841	0.16109	3.97502	0.6695	3.6277	4.13611	3.801	0.473
R2	79550	1465700	4.12894	0.83837	0.26321	4.96731	1.10158	4.39215	5.23052	4.680	0.779
R3	79550	1466300	2.71025	0.54583	0.17158	3.25608	0.71741	2.88183	3.42766	3.069	0.507
R4	78000	1465000	1.69107	0.31912	0.08652	2.01019	0.40564	1.77759	2.09671	1.894	0.287
R5	80000	1465000	1.7531	0.31457	0.0919	2.06767	0.40647	1.845	2.15957	1.956	0.287
R6	80000	1467000	1.88971	0.3208	0.09168	2.21051	0.41248	1.98139	2.30219	2.096	0.292
R7	78000	1467000	1.96442	0.33586	0.09802	2.30028	0.43388	2.06244	2.3983	2.181	0.307

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.40648	0.06584	0.02353	0.47232	0.08937	0.43001	0.49585	0.451	0.063
2nd Highest	79550	1466300	0.23	0.03937	0.01338	0.26937	0.05275	0.24338	0.28275	0.256	0.037

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.12894c	.83837c	.26321c	4.96731c	1.10157c	4.39214c	5.23051c		
Dates			90091424	90091424	90091424	90091424	90091424	90091424	90091424		

Scenario 2PM Year90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.11955	0.01769	0.00623	0.13724	0.02392	0.12578	0.14347	0.132	0.017
R2	79550	1465700	0.40513	0.06436	0.02324	0.46949	0.0876	0.42837	0.49273	0.449	0.062
R3	79550	1466300	0.20477	0.03352	0.01163	0.23829	0.04515	0.2164	0.24992	0.227	0.032
R4	78000	1465000	0.08922	0.01509	0.00433	0.10431	0.01942	0.09355	0.10864	0.099	0.014
R5	80000	1465000	0.16933	0.03115	0.00891	0.20048	0.04006	0.17824	0.20939	0.189	0.028
R6	80000	1467000	0.16078	0.02732	0.00801	0.1881	0.03533	0.16879	0.19611	0.178	0.025
R7	78000	1467000	0.17041	0.02844	0.00848	0.19885	0.03692	0.17889	0.20733	0.189	0.026

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	3.46661	0.50841	0.16109	3.97502	0.6695	3.6277	4.13611	3.801	0.473
R2	79550	1465700	4.12894	0.83837	0.26321	4.96731	1.10158	4.39215	5.23052	4.680	0.779
R3	79550	1466300	2.71025	0.5383	0.17158	3.24855	0.70988	2.88183	3.42013	3.065	0.502
R4	78000	1465000	1.69107	0.31912	0.08652	2.01019	0.40564	1.77759	2.09671	1.894	0.287
R5	80000	1465000	1.7551	0.31491	0.092	2.07001	0.40691	1.8471	2.16201	1.959	0.288
R6	80000	1467000	2.14221	0.35842	0.10284	2.50063	0.46126	2.24505	2.60347	2.373	0.326
R7	78000	1467000	1.93524	0.32976	0.09545	2.265	0.42521	2.03069	2.36045	2.148	0.301

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.40513	0.06436	0.02324	0.46949	0.0876	0.42837	0.49273	0.449	0.062
2nd Highest	79550	1466300	0.20477	0.03352	0.01163	0.23829	0.04515	0.2164	0.24992	0.227	0.032

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.12894c	.83837c	.26321c	4.96731c	1.10157c	4.39214c	5.23051c		
Dates			90091424	90091424	90091424	90091424	90091424	90091424	90091424		

Scenario 3PM Year90

Annual Average Concentrations in ug/m^3

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
R1	78400	1465800	0.09524	0.01377	0.00506	0.10901	0.01883	0.1003	0.11407	0.105	0.013
R2	79550	1465700	0.41126	0.06442	0.02351	0.47568	0.08793	0.43477	0.49919	0.455	0.062
R3	79550	1466300	0.20649	0.03226	0.01144	0.23875	0.0437	0.21793	0.25019	0.228	0.031
R4	78000	1465000	0.08686	0.01474	0.00426	0.1016	0.019	0.09112	0.10586	0.096	0.013
R5	80000	1465000	0.17484	0.03185	0.00917	0.20669	0.04102	0.18401	0.21586	0.195	0.029
R6	80000	1467000	0.16493	0.02814	0.00835	0.19307	0.03649	0.17328	0.20142	0.183	0.026
R7	78000	1467000	0.16448	0.02708	0.00813	0.19156	0.03521	0.17261	0.19969	0.182	0.025

First Highest Concentrations in ug/m^3

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
R1	78400	1465800	2.24661	0.38108	0.1196	2.62769	0.50068	2.36621	2.74729	2.497	0.354
R2	79550	1465700	4.12891	0.83837	0.26321	4.96728	1.10158	4.39212	5.23049	4.680	0.779
R3	79550	1466300	2.81785	0.51929	0.17842	3.33714	0.69771	2.99627	3.51556	3.167	0.493
R4	78000	1465000	1.69107	0.31912	0.08652	2.01019	0.40564	1.77759	2.09671	1.894	0.287
R5	80000	1465000	1.82605	0.32934	0.09569	2.15539	0.42503	1.92174	2.25108	2.039	0.301
R6	80000	1467000	2.14221	0.35842	0.10285	2.50063	0.46127	2.24506	2.60348	2.373	0.326
R7	78000	1467000	1.93524	0.32976	0.09545	2.265	0.42521	2.03069	2.36045	2.148	0.301

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.41126	0.06442	0.02351	0.47568	0.08793	0.43477	0.49919	0.455	0.062
2nd Highest	79550	1466300	0.20649	0.03226	0.01144	0.23875	0.0437	0.21793	0.25019	0.228	0.031

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.12891c	.83837c	.26321c	4.96728c	1.10157c	4.39212c	5.23049c		
Dates			90091424	90091424	90091424	90091424	90091424	90091424	90091424		

Scenario 4PM Year90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.08682	0.01207	0.00457	0.09889	0.01664	0.09139	0.10346	0.095	0.012
R2	79550	1465700	0.40584	0.06218	0.02283	0.46802	0.08501	0.42867	0.49085	0.448	0.060
R3	79550	1466300	0.21447	0.03285	0.01177	0.24732	0.04462	0.22624	0.25909	0.237	0.032
R4	78000	1465000	0.08802	0.01488	0.00431	0.1029	0.01919	0.09233	0.10721	0.098	0.014
R5	80000	1465000	0.18444	0.0335	0.00967	0.21794	0.04317	0.19411	0.22761	0.206	0.031
R6	80000	1467000	0.17826	0.03064	0.00912	0.2089	0.03976	0.18738	0.21802	0.198	0.028
R7	78000	1467000	0.16482	0.0271	0.00814	0.19192	0.03524	0.17296	0.20006	0.182	0.025

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.24522	0.33144	0.10415	2.57666	0.43559	2.34937	2.68081	2.463	0.308
R2	79550	1465700	3.66667	0.73751	0.23954	4.40418	0.97705	3.90621	4.64372	4.155	0.691
R3	79550	1466300	2.70412	0.48737	0.16815	3.19149	0.65552	2.87227	3.35964	3.032	0.464
R4	78000	1465000	2.56979	0.36717	0.11324	2.93696	0.48041	2.68303	3.0502	2.810	0.340
R5	80000	1465000	1.79909	0.32327	0.09427	2.12236	0.41754	1.89336	2.21663	2.008	0.295
R6	80000	1467000	2.1418	0.3584	0.10284	2.5002	0.46124	2.24464	2.60304	2.372	0.326
R7	78000	1467000	1.93523	0.32976	0.09545	2.26499	0.42521	2.03068	2.36044	2.148	0.301

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.40584	0.06218	0.02283	0.46802	0.08501	0.42867	0.49085	0.448	0.060
2nd Highest	79550	1466300	0.21447	0.0335	0.01177	0.24797	0.04527	0.22624	0.25974	0.237	0.032

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	3.66667c	0.73751	0.23954	4.38917c	0.97705	3.89309c	4.61559c		
Dates			90091424	90041724	90041724	90091424	90041724	90091424	90091424		

Scenario 5PM Year90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.07931	0.01079	0.00406	0.0901	0.01485	0.08337	0.09416	0.087	0.011
R2	79550	1465700	0.40542	0.06117	0.02258	0.46659	0.08375	0.428	0.48917	0.447	0.059
R3	79550	1466300	0.23216	0.03519	0.0126	0.26735	0.04779	0.24476	0.27995	0.256	0.034
R4	78000	1465000	0.08754	0.01465	0.00422	0.10219	0.01887	0.09176	0.10641	0.097	0.013
R5	80000	1465000	0.18788	0.03407	0.00985	0.22195	0.04392	0.19773	0.2318	0.210	0.031
R6	80000	1467000	0.19205	0.033	0.00984	0.22505	0.04284	0.20189	0.23489	0.213	0.030
R7	78000	1467000	0.16592	0.02725	0.00819	0.19317	0.03544	0.17411	0.20136	0.184	0.025

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	1.67383	0.21513	0.07519	1.88896	0.29032	1.74902	1.96415	1.819	0.205
R2	79550	1465700	3.29459	0.671	0.21948	3.96559	0.89048	3.51407	4.18507	3.740	0.630
R3	79550	1466300	2.68673	0.49372	0.17322	3.18045	0.66694	2.85995	3.35367	3.020	0.472
R4	78000	1465000	2.56744	0.36591	0.11278	2.93335	0.47869	2.68022	3.04613	2.807	0.338
R5	80000	1465000	1.6359	0.3129	0.0858	1.9488	0.3987	1.7217	2.0346	1.835	0.282
R6	80000	1467000	1.93521	0.34621	0.10534	2.28142	0.45155	2.04055	2.38676	2.161	0.319
R7	78000	1467000	2.23584	0.38631	0.11168	2.62215	0.49799	2.34752	2.73383	2.485	0.352

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.40542	0.06117	0.02258	0.46659	0.08375	0.428	0.48917	0.447	0.059
2nd Highest	79550	1466300	0.23216	0.03519	0.0126	0.26735	0.04779	0.24476	0.27995	0.256	0.034

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	3.29459	0.671	0.0126	3.91739	0.89049	3.46587	4.13687		
Dates			90121324	90041724	90041724	90041724	90041724	90041724	90041724		

Scenario 6PM Year 90

Annual Average Concentrations in ug/m^3

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
R1	78400	1465800	0.07848	0.0105	0.00389	0.08898	0.01439	0.08237	0.09287	0.086	0.010
R2	79550	1465700	0.39544	0.05942	0.02187	0.45486	0.08129	0.41731	0.47673	0.436	0.057
R3	79550	1466300	0.26358	0.04145	0.01471	0.30503	0.05616	0.27829	0.31974	0.292	0.040
R4	78000	1465000	0.08121	0.01362	0.00393	0.09483	0.01755	0.08514	0.09876	0.090	0.012
R5	80000	1465000	0.19129	0.03479	0.01003	0.22608	0.04482	0.20132	0.23611	0.214	0.032
R6	80000	1467000	0.19753	0.03385	0.01003	0.23138	0.04388	0.20756	0.24141	0.219	0.031
R7	78000	1467000	0.16749	0.02763	0.00825	0.19512	0.03588	0.17574	0.20337	0.185	0.025

First Highest Concentrations in ug/m^3

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
R1	78400	1465800	1.74628	0.1871	0.0777	1.93338	0.2648	1.82398	2.01108	1.879	0.187
R2	79550	1465700	3.20671	0.62774	0.20634	3.83445	0.83408	3.41305	4.04079	3.624	0.590
R3	79550	1466300	2.8416	0.4957	0.17355	3.3373	0.66925	3.01515	3.51085	3.176	0.473
R4	78000	1465000	2.56744	0.36591	0.11278	2.93335	0.47869	2.68022	3.04613	2.807	0.338
R5	80000	1465000	1.58959	0.30456	0.08332	1.89415	0.38788	1.67291	1.97747	1.784	0.274
R6	80000	1467000	2.15936	0.36569	0.11024	2.52505	0.47593	2.2696	2.63529	2.397	0.337
R7	78000	1467000	2.4549	0.42409	0.1231	2.87899	0.54719	2.578	3.00209	2.728	0.387

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.39544	0.05942	0.02187	0.45486	0.08129	0.41731	0.47673	0.436	0.057
2nd Highest	79550	1466300	0.26358	0.04145	0.01471	0.30503	0.05616	0.27829	0.31974	0.292	0.040

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	3.20671	0.62774	0.20634	3.74831	0.83408	3.37009	3.95464		
Dates			90061924	90041724	90041724	90041724	90041724	90061924	90041724		

Scenario 7PM Year 90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.08078	0.01132	0.00406	0.0921	0.01538	0.08484	0.09616	0.088	0.011
R2	79550	1465700	0.40409	0.0614	0.02259	0.46549	0.08399	0.42668	0.48808	0.446	0.059
R3	79550	1466300	0.2888	0.04616	0.01626	0.33496	0.06242	0.30506	0.35122	0.320	0.044
R4	78000	1465000	0.07994	0.01346	0.00387	0.0934	0.01733	0.08381	0.09727	0.089	0.012
R5	80000	1465000	0.19135	0.03497	0.01004	0.22632	0.04501	0.20139	0.23636	0.214	0.032
R6	80000	1467000	0.20053	0.03433	0.01012	0.23486	0.04445	0.21065	0.24498	0.223	0.031
R7	78000	1467000	0.15067	0.02464	0.0074	0.17531	0.03204	0.15807	0.18271	0.167	0.023

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	1.72619	0.18716	0.07771	1.91335	0.26487	1.8039	1.99106	1.859	0.187
R2	79550	1465700	3.70983	0.62838	0.22544	4.33821	0.85382	3.93527	4.56365	4.137	0.604
R3	79550	1466300	3.16904	0.49355	0.17681	3.66259	0.67036	3.34585	3.8394	3.504	0.474
R4	78000	1465000	2.53225	0.35239	0.10791	2.88464	0.4603	2.64016	2.99255	2.762	0.325
R5	80000	1465000	1.57941	0.29917	0.08359	1.87858	0.38276	1.663	1.96217	1.771	0.271
R6	80000	1467000	2.13557	0.36142	0.10364	2.49699	0.46506	2.23921	2.60063	2.368	0.329
R7	78000	1467000	1.94645	0.33185	0.09731	2.2783	0.42916	2.04376	2.37561	2.161	0.303

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.40409	0.0614	0.02259	0.46549	0.08399	0.42668	0.48808	0.446	0.059
2nd Highest	79550	1466300	0.2888	0.04616	0.01626	0.33496	0.06242	0.30506	0.35122	0.320	0.044

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	3.70983c	0.62838	0.22544	4.29972	0.83494	3.91867	4.52517		
Dates			90092624	90041724	90091524	90091524	90041724	90091524	90091524		

Scenario 8PM Year90

Annual Average Concentrations in ug/m³

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.08496	0.01249	0.0044	0.09745	0.01689	0.08936	0.10185	0.093	0.012
R2	79550	1465700	0.41387	0.06373	0.02315	0.4776	0.08688	0.43702	0.50075	0.457	0.061
R3	79550	1466300	0.30852	0.05059	0.01767	0.35911	0.06826	0.32619	0.37678	0.343	0.048
R4	78000	1465000	0.07353	0.01261	0.00359	0.08614	0.0162	0.07712	0.08973	0.082	0.011
R5	80000	1465000	0.19149	0.03481	0.01	0.2263	0.04481	0.20149	0.2363	0.214	0.032
R6	80000	1467000	0.20444	0.03511	0.01028	0.23955	0.04539	0.21472	0.24983	0.227	0.032
R7	78000	1467000	0.13888	0.02266	0.0068	0.16154	0.02946	0.14568	0.16834	0.154	0.021

First Highest Concentrations in ug/m³

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.11237	0.25482	0.08403	2.36719	0.33885	2.1964	2.45122	2.282	0.240
R2	79550	1465700	4.36472	0.72336	0.26514	5.08808	0.9885	4.62986	5.35322	4.859	0.699
R3	79550	1466300	3.1691	0.53575	0.19769	3.70485	0.73344	3.36679	3.90254	3.536	0.519
R4	78000	1465000	2.53183	0.35237	0.10791	2.8842	0.46028	2.63974	2.99211	2.762	0.325
R5	80000	1465000	1.98559	0.35701	0.10402	2.3426	0.46103	2.08961	2.44662	2.216	0.326
R6	80000	1467000	1.89883	0.31137	0.08935	2.2102	0.40072	1.98818	2.29955	2.099	0.283
R7	78000	1467000	1.94645	0.33185	0.09731	2.2783	0.42916	2.04376	2.37561	2.161	0.303

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.41387	0.06373	0.02315	0.4776	0.08688	0.43702	0.50075	0.457	0.061
2nd Highest	79550	1466300	0.30852	0.05059	0.01767	0.35911	0.06826	0.32619	0.37678	0.343	0.048

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.36472	0.72336	0.26514	5.08808	0.9885	4.62985	5.35321		
Dates			90091524	90091524	90091524	90091524	90091524	90091524	90091524		

Scenario 9PM Year 90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.08715	0.01335	0.00472	0.1005	0.01807	0.09187	0.10522	0.096	0.013
R2	79550	1465700	0.42598	0.06605	0.02388	0.49203	0.08993	0.44986	0.51591	0.471	0.064
R3	79550	1466300	0.33417	0.05546	0.01915	0.38963	0.07461	0.35332	0.40878	0.371	0.053
R4	78000	1465000	0.07665	0.01311	0.00371	0.08976	0.01682	0.08036	0.09347	0.085	0.012
R5	80000	1465000	0.18881	0.03447	0.00986	0.22328	0.04433	0.19867	0.23314	0.211	0.031
R6	80000	1467000	0.21319	0.03657	0.01063	0.24976	0.0472	0.22382	0.26039	0.237	0.033
R7	78000	1467000	0.12778	0.02093	0.00624	0.14871	0.02717	0.13402	0.15495	0.141	0.019

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.11237	0.25482	0.08403	2.36719	0.33885	2.1964	2.45122	2.282	0.240
R2	79550	1465700	4.90345	0.72336	0.26514	5.62681	0.9885	5.16859	5.89195	5.398	0.699
R3	79550	1466300	3.64138	0.53887	0.19823	4.18025	0.7371	3.83961	4.37848	4.010	0.521
R4	78000	1465000	2.51074	0.35107	0.10763	2.86181	0.4587	2.61837	2.96944	2.740	0.324
R5	80000	1465000	1.98559	0.35701	0.10402	2.3426	0.46103	2.08961	2.44662	2.216	0.326
R6	80000	1467000	1.92822	0.30008	0.08756	2.2283	0.38764	2.01578	2.31586	2.122	0.274
R7	78000	1467000	1.91202	0.34705	0.09552	2.25907	0.44257	2.00754	2.35459	2.133	0.313

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.42598	0.06605	0.02388	0.49203	0.08993	0.44986	0.51591	0.471	0.064
2nd Highest	79550	1466300	0.33417	0.05546	0.01915	0.38963	0.07461	0.35332	0.40878	0.371	0.053

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.90345c	0.72336	0.26514	5.56484c	0.9885	5.14987c	5.81126c		
Dates			90092624	90091524	90091524	90092624	90091524	90092624	90092624		

Scenario 10PM Year90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.09904	0.01623	0.00562	0.11527	0.02185	0.10466	0.12089	0.110	0.015
R2	79550	1465700	0.42868	0.06714	0.02404	0.49582	0.09118	0.45272	0.51986	0.474	0.064
R3	79550	1466300	0.36055	0.06105	0.02081	0.4216	0.08186	0.38136	0.44241	0.401	0.058
R4	78000	1465000	0.07774	0.01319	0.00371	0.09093	0.0169	0.08145	0.09464	0.086	0.012
R5	80000	1465000	0.19198	0.03508	0.01003	0.22706	0.04511	0.20201	0.23709	0.215	0.032
R6	80000	1467000	0.21355	0.03663	0.01061	0.25018	0.04724	0.22416	0.26079	0.237	0.033
R7	78000	1467000	0.12488	0.02057	0.00608	0.14545	0.02665	0.13096	0.15153	0.138	0.019

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.11237	0.2819	0.08647	2.39427	0.36837	2.19884	2.48074	2.297	0.260
R2	79550	1465700	5.25821	0.84844	0.30984	6.10665	1.15828	5.56805	6.41649	5.837	0.819
R3	79550	1466300	4.03139	0.55136	0.17071	4.58275	0.72207	4.2021	4.75346	4.392	0.511
R4	78000	1465000	1.74516	0.3278	0.09127	2.07296	0.41907	1.83643	2.16423	1.955	0.296
R5	80000	1465000	1.98559	0.36091	0.10402	2.3465	0.46493	2.08961	2.45052	2.218	0.329
R6	80000	1467000	1.92822	0.30987	0.08882	2.23809	0.39869	2.01704	2.32691	2.128	0.282
R7	78000	1467000	1.69646	0.29882	0.08483	1.99528	0.38365	1.78129	2.08011	1.888	0.271

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.42868	0.06714	0.02404	0.49582	0.09118	0.45272	0.51986	0.474	0.064
2nd Highest	79550	1466300	0.36055	0.06105	0.02081	0.4216	0.08186	0.38136	0.44241	0.401	0.058

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	5.25821c	0.84844	0.30984	6.02737	1.15827	5.51961c	6.33721		
Dates			90092624	90091524	90091524	90091524	90091524	90092624	90091524		

Scenario 11PM Year 90

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.12335	0.0201	0.00677	0.14345	0.02687	0.13012	0.15022	0.137	0.019
R2	79550	1465700	0.42478	0.06774	0.02401	0.49252	0.09175	0.44879	0.51653	0.471	0.065
R3	79550	1466300	0.3836	0.06578	0.02228	0.44938	0.08806	0.40588	0.47166	0.428	0.062
R4	78000	1465000	0.07762	0.01308	0.00367	0.0907	0.01675	0.08129	0.09437	0.086	0.012
R5	80000	1465000	0.19179	0.03531	0.01002	0.2271	0.04533	0.20181	0.23712	0.214	0.032
R6	80000	1467000	0.21746	0.03714	0.01068	0.2546	0.04782	0.22814	0.26528	0.241	0.034
R7	78000	1467000	0.13011	0.02161	0.00634	0.15172	0.02795	0.13645	0.15806	0.144	0.020

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.65485	0.50658	0.14588	3.16143	0.65246	2.80073	3.30731	2.981	0.461
R2	79550	1465700	5.40399	0.83789	0.30353	6.24188	1.14142	5.70752	6.54541	5.975	0.807
R3	79550	1466300	4.03353	0.59082	0.18739	4.62435	0.77821	4.22092	4.81174	4.423	0.550
R4	78000	1465000	2.12484	0.36138	0.09089	2.48622	0.45227	2.21573	2.57711	2.351	0.320
R5	80000	1465000	1.98559	0.3891	0.10402	2.37469	0.49312	2.08961	2.47871	2.232	0.349
R6	80000	1467000	1.98101	0.35707	0.10077	2.33808	0.45784	2.08178	2.43885	2.210	0.324
R7	78000	1467000	1.57299	0.28581	0.07783	1.8588	0.36364	1.65082	1.93663	1.755	0.257

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.42478	0.06774	0.02401	0.49252	0.09175	0.44879	0.51653	0.471	0.065
2nd Highest	79550	1466300	0.3836	0.06578	0.02228	0.44938	0.08806	0.40588	0.47166	0.428	0.062

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	5.40399c	0.83789	0.30353	6.16257c	1.14142	5.68061c	6.43919c		
Dates			90092624	90091524	90091524	90092624	90091524	90092624	90092624		

Scenario 7AM	Year 91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.17431	0.02983	0.01041	0.20414	0.04024	0.18472	0.21455	0.194	0.028
R2	79550	1465700	0.43431	0.06901	0.02497	0.50332	0.09398	0.45928	0.52829	0.481	0.066
R3	79550	1466300	0.46317	0.07376	0.02493	0.53693	0.09869	0.4881	0.56186	0.513	0.070
R4	78000	1465000	0.10983	0.01911	0.00548	0.12894	0.02459	0.11531	0.13442	0.122	0.017
R5	80000	1465000	0.15353	0.02806	0.00802	0.18159	0.03608	0.16155	0.18961	0.172	0.026
R6	80000	1467000	0.20953	0.03617	0.01031	0.2457	0.04648	0.21984	0.25601	0.233	0.033
R7	78000	1467000	0.13467	0.02315	0.00664	0.15782	0.02979	0.14131	0.16446	0.150	0.021

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.86576	0.44568	0.1452	3.31144	0.59088	3.01096	3.45664	3.161	0.418
R2	79550	1465700	4.38584	0.81149	0.25144	5.19733	1.06293	4.63728	5.44877	4.917	0.752
R3	79550	1466300	4.22936	0.73693	0.22518	4.96629	0.96211	4.45454	5.19147	4.710	0.680
R4	78000	1465000	1.99366	0.34946	0.10818	2.34312	0.45764	2.10184	2.4513	2.222	0.324
R5	80000	1465000	1.7183	0.34161	0.09191	2.05991	0.43352	1.81021	2.15182	1.935	0.307
R6	80000	1467000	1.88293	0.39605	0.10802	2.27898	0.50407	1.99095	2.387	2.135	0.356
R7	78000	1467000	1.71527	0.29652	0.08689	2.01179	0.38341	1.80216	2.09868	1.907	0.271

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.46317	0.07376	0.02497	0.53693	0.09873	0.48814	0.5619	0.513	0.070
2nd Highest	79550	1466300	0.43431	0.06901	0.02493	0.50332	0.09394	0.45924	0.52825	0.481	0.066

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.38584	0.81149	0.25144	5.19733	1.06293	4.63728	5.44877		
Dates			91091024	91091024	91091024	91091024	91091024	91091024	91091024		

Scenario 8 AM Year 91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.16953	0.02894	0.01003	0.19847	0.03897	0.17956	0.2085	0.189	0.028
R2	79550	1465700	0.43309	0.06788	0.02467	0.50097	0.09255	0.45776	0.52564	0.479	0.065
R3	79550	1466300	0.45119	0.07175	0.02428	0.52294	0.09603	0.47547	0.54722	0.499	0.068
R4	78000	1465000	0.10396	0.01834	0.00526	0.1223	0.0236	0.10922	0.12756	0.116	0.017
R5	80000	1465000	0.14415	0.02635	0.00753	0.1705	0.03388	0.15168	0.17803	0.161	0.024
R6	80000	1467000	0.20213	0.03466	0.00984	0.23679	0.0445	0.21197	0.24663	0.224	0.031
R7	78000	1467000	0.13487	0.02302	0.00668	0.15789	0.0297	0.14155	0.16457	0.150	0.021

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.73896	0.38741	0.13065	3.12637	0.51806	2.86961	3.25702	2.998	0.366
R2	79550	1465700	4.53384	0.80118	0.2501	5.33502	1.05128	4.78394	5.58512	5.059	0.743
R3	79550	1466300	4.2316	0.73695	0.22518	4.96855	0.96213	4.45678	5.19373	4.713	0.680
R4	78000	1465000	1.99856	0.34946	0.10818	2.34802	0.45764	2.10674	2.4562	2.227	0.324
R5	80000	1465000	1.71999	0.342	0.092	2.06199	0.434	1.81199	2.15399	1.937	0.307
R6	80000	1467000	1.88293	0.4026	0.11013	2.28553	0.51273	1.99306	2.39566	2.139	0.363
R7	78000	1467000	1.72677	0.29652	0.08689	2.02329	0.38341	1.81366	2.11018	1.918	0.271

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.45119	0.07175	0.02467	0.52294	0.09642	0.47586	0.54761	0.499	0.068
2nd Highest	79550	1466300	0.43309	0.06788	0.02428	0.50097	0.09216	0.45737	0.52525	0.479	0.065

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	4.53384	0.80118	0.2501	5.33502	1.05128	4.78394	5.58512		
Dates			91091024	91091024	91091024	91091024	91091024	91091024	91091024		

Scenario 9AM | Year 91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.16295	0.02805	0.00977	0.191	0.03782	0.17272	0.20077	0.182	0.027
R2	79550	1465700	0.41772	0.06488	0.02382	0.4826	0.0887	0.44154	0.50642	0.462	0.063
R3	79550	1466300	0.41831	0.06754	0.02291	0.48585	0.09045	0.44122	0.50876	0.464	0.064
R4	78000	1465000	0.09704	0.01735	0.00498	0.11439	0.02233	0.10202	0.11937	0.108	0.016
R5	80000	1465000	0.14023	0.02558	0.00733	0.16581	0.03291	0.14756	0.17314	0.157	0.023
R6	80000	1467000	0.20369	0.03473	0.0099	0.23842	0.04463	0.21359	0.24832	0.226	0.032
R7	78000	1467000	0.12938	0.02199	0.00641	0.15137	0.0284	0.13579	0.15778	0.144	0.020

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.4213	0.38741	0.13065	2.80871	0.51806	2.55195	2.93936	2.680	0.366
R2	79550	1465700	3.93466	0.68079	0.21513	4.61545	0.89592	4.14979	4.83058	4.383	0.634
R3	79550	1466300	3.93125	0.6989	0.22036	4.63015	0.91926	4.15161	4.85051	4.391	0.650
R4	78000	1465000	1.99856	0.34946	0.10818	2.34802	0.45764	2.10674	2.4562	2.227	0.324
R5	80000	1465000	1.69684	0.30442	0.09145	2.00126	0.39587	1.78829	2.09271	1.895	0.280
R6	80000	1467000	1.88221	0.4026	0.11013	2.28481	0.51273	1.99234	2.39494	2.139	0.363
R7	78000	1467000	1.72677	0.2929	0.08593	2.01967	0.37883	1.8127	2.1056	1.916	0.268

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.41831	0.06754	0.02382	0.48585	0.09136	0.44213	0.50967	0.464	0.065
2nd Highest	79550	1466300	0.41772	0.06488	0.02291	0.4826	0.08779	0.44063	0.50551	0.462	0.062

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300		.69890c	0.22036		.91459c	4.15161		#DIV/0!	#DIV/0!
	79550	1465700	3.93466			4.61545			4.83059		
Dates			91091024	91051124	91122224	91091024	91051124	91122224	91091024		

Scenario10 AM Year91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.15487	0.02645	0.00919	0.18132	0.03564	0.19051	0.21696	0.186	0.044
R2	79550	1465700	0.41067	0.06265	0.0233	0.47332	0.08595	0.43397	0.49662	0.454	0.061
R3	79550	1466300	0.37776	0.05973	0.02037	0.43749	0.0801	0.39813	0.45786	0.418	0.057
R4	78000	1465000	0.09624	0.01686	0.00485	0.1131	0.02171	0.10109	0.11795	0.107	0.015
R5	80000	1465000	0.13432	0.02469	0.00705	0.15901	0.03174	0.14137	0.16606	0.150	0.022
R6	80000	1467000	0.2005	0.03447	0.00986	0.23497	0.04433	0.21036	0.24483	0.223	0.031
R7	78000	1467000	0.12963	0.02202	0.00645	0.15165	0.02847	0.13608	0.1581	0.144	0.020

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.50987	0.47107	0.13556	2.98094	0.60663	3.1165	3.58757	1.871	2.427
R2	79550	1465700	3.73216	0.64596	0.23019	4.37812	0.87615	4.60831	5.25427	2.832	3.425
R3	79550	1466300	3.92781	0.57493	0.21831	4.50274	0.79324	4.72105	5.29598	2.837	3.478
R4	78000	1465000	1.99856	0.34946	0.10818	2.34802	0.45764	2.4562	2.80566	1.451	1.916
R5	80000	1465000	1.68799	0.30274	0.09098	1.99073	0.39372	2.08171	2.38445	1.259	1.591
R6	80000	1467000	1.66068	0.35771	0.09755	2.01839	0.45526	2.11594	2.47365	1.337	1.607
R7	78000	1467000	1.69803	0.2929	0.08515	1.99093	0.37805	2.07608	2.36898	1.249	1.583

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.41067	0.06265	0.0233	0.47332	0.08595	0.43397	0.49662	0.454	0.061
2nd Highest	79550	1466300	0.37776	0.05973	0.02037	0.43749	0.0801	0.39813	0.45786	0.418	0.057

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	3.92781			4.48706		4.14612	4.70537	4.317	0.550
	79550	1465700		0.64596	0.23019		0.87614				
Dates			91122224	91112524	91112524	91122224	91112524	91122224	91122224		

Scenario11 AM | Year91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.15191	0.02525	0.00886	0.17716	0.03411	0.18602	0.21127	0.182	0.042
R2	79550	1465700	0.41083	0.06167	0.02316	0.4725	0.08483	0.49566	0.55733	0.484	0.104
R3	79550	1466300	0.35858	0.05589	0.01919	0.41447	0.07508	0.43366	0.48955	0.424	0.093
R4	78000	1465000	0.09227	0.01575	0.00454	0.10802	0.02029	0.11256	0.12831	0.110	0.025
R5	80000	1465000	0.13229	0.02427	0.00694	0.15656	0.03121	0.1635	0.18777	0.160	0.039
R6	80000	1467000	0.19188	0.03297	0.00952	0.22485	0.04249	0.23437	0.26734	0.230	0.053
R7	78000	1467000	0.12887	0.02181	0.00642	0.15068	0.02823	0.1571	0.17891	0.154	0.035

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.50987	0.47107	0.13556	2.98094	0.60663	3.1165	3.58757	3.049	0.762
R2	79550	1465700	3.46064	0.64445	0.2297	4.10509	0.87415	4.33479	4.97924	4.220	1.074
R3	79550	1466300	3.68742	0.56913	0.20945	4.25655	0.77858	4.466	5.03513	4.361	0.953
R4	78000	1465000	1.65866	0.26741	0.08069	1.92607	0.3481	2.00676	2.27417	1.966	0.435
R5	80000	1465000	1.56792	0.28467	0.08473	1.85259	0.3694	1.93732	2.22199	1.895	0.462
R6	80000	1467000	1.59276	0.30715	0.08736	1.89991	0.39451	1.98727	2.29442	1.944	0.496
R7	78000	1467000	1.69739	0.29278	0.08512	1.99017	0.3779	2.07529	2.36807	2.033	0.474

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.41083	0.06167	0.02316	0.4725	0.08483	0.49566	0.55733	0.484	0.104
2nd Highest	79550	1466300	0.35858	0.05589	0.01919	0.41447	0.07508	0.43366	0.48955	0.424	0.093

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	3.68742			4.25655		3.88973	4.45887	4.073	0.545
	79550	1465700		0.64445	0.2297		0.87414				
Dates			91010424	91112524	91112524	91010424	91112524	91010424	91010424		

Scenario 12PM | **Year 91**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.13601	0.0225	0.00804	0.15851	0.03054	0.16655	0.18905	0.163	0.038
R2	79550	1465700	0.40145	0.05984	0.02264	0.46129	0.08248	0.48393	0.54377	0.473	0.101
R3	79550	1466300	0.34615	0.05368	0.01881	0.39983	0.07249	0.41864	0.47232	0.409	0.089
R4	78000	1465000	0.08957	0.01507	0.00434	0.10464	0.01941	0.10898	0.12405	0.107	0.024
R5	80000	1465000	0.13339	0.02427	0.00699	0.15766	0.03126	0.16465	0.18892	0.161	0.039
R6	80000	1467000	0.18698	0.03194	0.00928	0.21892	0.04122	0.2282	0.26014	0.224	0.052
R7	78000	1467000	0.13195	0.02233	0.00661	0.15428	0.02894	0.16089	0.18322	0.158	0.036

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.50799	0.46964	0.13679	2.97763	0.60643	3.11442	3.58406	3.046	0.761
R2	79550	1465700	3.2271	0.55072	0.19531	3.77782	0.74603	3.97313	4.52385	3.875	0.917
R3	79550	1466300	4.0387	0.57345	0.20762	4.61215	0.78107	4.81977	5.39322	4.716	0.958
R4	78000	1465000	1.7469	0.25948	0.07789	2.00638	0.33737	2.08427	2.34375	2.045	0.422
R5	80000	1465000	1.44291	0.28467	0.07822	1.72758	0.36289	1.8058	2.09047	1.767	0.458
R6	80000	1467000	1.60407	0.30546	0.08736	1.90953	0.39282	1.99689	2.30235	1.953	0.494
R7	78000	1467000	1.7679	0.30325	0.08975	2.07115	0.393	2.1609	2.46415	2.116	0.492

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.40145	0.05984	0.02264	0.46129	0.08248	0.48393	0.54377	0.473	0.101
2nd Highest	79550	1466300	0.34615	0.05368	0.01881	0.39983	0.07249	0.41864	0.47232	0.409	0.089

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.0387	0.57345	.20762c	4.61215	0.77426	4.23951	4.81296	4.426	0.547
Dates			91010424	91010424	91020224	91010424	91010424	91010424	91010424		

Scenario 1PM Year91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.12036	0.01967	0.00721	0.14003	0.02688	0.14724	0.16691	0.144	0.033
R2	79550	1465700	0.38106	0.0558	0.02141	0.43686	0.07721	0.45827	0.51407	0.448	0.094
R3	79550	1466300	0.32785	0.05092	0.01814	0.37877	0.06906	0.39691	0.44783	0.388	0.085
R4	78000	1465000	0.08775	0.01488	0.0043	0.10263	0.01918	0.10693	0.12181	0.105	0.024
R5	80000	1465000	0.13358	0.0243	0.00701	0.15788	0.03131	0.16489	0.18919	0.161	0.039
R6	80000	1467000	0.18492	0.03162	0.00921	0.21654	0.04083	0.22575	0.25737	0.221	0.051
R7	78000	1467000	0.13468	0.02267	0.00675	0.15735	0.02942	0.1641	0.18677	0.161	0.037

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.79379	0.51296	0.17001	3.30675	0.68297	3.47676	3.98972	3.392	0.846
R2	79550	1465700	3.16028	0.51379	0.16657	3.67407	0.68036	3.84064	4.35443	3.757	0.844
R3	79550	1466300	3.86771	0.56358	0.20762	4.43129	0.7712	4.63891	5.20249	4.535	0.944
R4	78000	1465000	1.75828	0.26037	0.07789	2.01865	0.33826	2.09654	2.35691	2.058	0.423
R5	80000	1465000	1.44291	0.28467	0.07822	1.72758	0.36289	1.8058	2.09047	1.767	0.458
R6	80000	1467000	1.60407	0.30546	0.08684	1.90953	0.3923	1.99637	2.30183	1.953	0.493
R7	78000	1467000	1.76781	0.30323	0.08975	2.07104	0.39298	2.16079	2.46402	2.116	0.492

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.38106	0.0558	0.02141	0.43686	0.07721	0.45827	0.51407	0.448	0.094
2nd Highest	79550	1466300	0.32785	0.05092	0.01814	0.37877	0.06906	0.39691	0.44783	0.388	0.085

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	3.86771	0.56358	.20762c	4.43129	.76731c	4.0663	4.62988	4.249	0.539
Dates			91010424	91010424	91020224	91010424	91020224	91010424	91010424		

Scenario 2PM Year91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.10639	0.01667	0.00635	0.12306	0.02302	0.12941	0.14608	0.126	0.028
R2	79550	1465700	0.36412	0.05249	0.02038	0.41661	0.07287	0.43699	0.48948	0.427	0.089
R3	79550	1466300	0.3211	0.04833	0.01746	0.36943	0.06579	0.38689	0.43522	0.378	0.081
R4	78000	1465000	0.08737	0.01479	0.0043	0.10216	0.01909	0.10646	0.12125	0.104	0.024
R5	80000	1465000	0.13333	0.02426	0.007	0.15759	0.03126	0.16459	0.18885	0.161	0.039
R6	80000	1467000	0.18343	0.03114	0.00916	0.21457	0.0403	0.22373	0.25487	0.219	0.051
R7	78000	1467000	0.14151	0.0239	0.00713	0.16541	0.03103	0.17254	0.19644	0.169	0.039

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.30869	0.42269	0.14002	2.73138	0.56271	2.8714	3.29409	2.801	0.697
R2	79550	1465700	3.30851	0.51379	0.16946	3.8223	0.68325	3.99176	4.50555	3.907	0.846
R3	79550	1466300	3.62409	0.5671	0.21193	4.19119	0.77903	4.40312	4.97022	4.297	0.952
R4	78000	1465000	1.65835	0.2621	0.07789	1.92045	0.33999	1.99834	2.26044	1.959	0.426
R5	80000	1465000	1.62272	0.32969	0.08632	1.95241	0.41601	2.03873	2.36842	1.996	0.527
R6	80000	1467000	1.58693	0.27504	0.07931	1.86197	0.35435	1.94128	2.21632	1.902	0.445
R7	78000	1467000	1.29613	0.24252	0.06641	1.53865	0.30893	1.60506	1.84758	1.572	0.390

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.36412	0.05249	0.02038	0.41661	0.07287	0.43699	0.48948	0.427	0.089
2nd Highest	79550	1466300	0.3211	0.04833	0.01746	0.36943	0.06579	0.38689	0.43522	0.378	0.081

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	3.62409	0.5671	0.21193	4.19119	0.77903	3.83602	4.40312	4.014	0.551
Dates			91010424	91010424	91010424	91010424	91010424	91010424	91010424		

Scenario 3PM Year 91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.09823	0.0151	0.00578	0.11333	0.02088	0.11911	0.13421	0.116	0.025
R2	79550	1465700	0.36393	0.05144	0.0202	0.41537	0.07164	0.43557	0.48701	0.425	0.087
R3	79550	1466300	0.33681	0.04981	0.01843	0.38662	0.06824	0.40505	0.45486	0.396	0.083
R4	78000	1465000	0.08467	0.01431	0.00419	0.09898	0.0185	0.10317	0.11748	0.101	0.023
R5	80000	1465000	0.13239	0.0239	0.00695	0.15629	0.03085	0.16324	0.18714	0.160	0.039
R6	80000	1467000	0.1908	0.03227	0.00951	0.22307	0.04178	0.23258	0.26485	0.228	0.052
R7	78000	1467000	0.14117	0.02379	0.0071	0.16496	0.03089	0.17206	0.19585	0.169	0.039

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.30866	0.43826	0.14596	2.74692	0.58422	2.89288	3.33114	2.820	0.723
R2	79550	1465700	3.86904	0.43374	0.18069	4.30278	0.61443	4.48347	4.91721	4.393	0.741
R3	79550	1466300	3.62146	0.56968	0.21351	4.19114	0.78319	4.40465	4.97433	4.298	0.957
R4	78000	1465000	1.52191	0.2621	0.07342	1.78401	0.33552	1.85743	2.11953	1.821	0.423
R5	80000	1465000	1.72758	0.34848	0.09202	2.07606	0.4405	2.16808	2.51656	2.122	0.558
R6	80000	1467000	1.55612	0.26672	0.07931	1.82284	0.34603	1.90215	2.16887	1.862	0.433
R7	78000	1467000	1.48914	0.25551	0.07779	1.74465	0.3333	1.82244	2.07795	1.784	0.416

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.36393	0.05144	0.0202	0.41537	0.07164	0.43557	0.48701	0.425	0.087
2nd Highest	79550	1466300	0.33681	0.04981	0.01843	0.38662	0.06824	0.40505	0.45486	0.396	0.083

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300		0.56968	0.21351		0.78319	4.04973	4.45501		
	79550	1465700	3.86904			4.27432					
Dates			91022524	91010424	91010424	91022524	91022524	91022524	91022524		

Scenario 4PM Year 91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.08441	0.01249	0.00497	0.0969	0.01746	0.10187	0.11436	0.099	0.021
R2	79550	1465700	0.36114	0.05075	0.01998	0.41189	0.07073	0.43187	0.48262	0.422	0.086
R3	79550	1466300	0.34399	0.05041	0.01872	0.3944	0.06913	0.41312	0.46353	0.404	0.085
R4	78000	1465000	0.0871	0.01439	0.00421	0.10149	0.0186	0.1057	0.12009	0.104	0.023
R5	80000	1465000	0.14006	0.02524	0.00734	0.1653	0.03258	0.17264	0.19788	0.169	0.041
R6	80000	1467000	0.19337	0.03292	0.00974	0.22629	0.04266	0.23603	0.26895	0.231	0.053
R7	78000	1467000	0.14473	0.02438	0.00727	0.16911	0.03165	0.17638	0.20076	0.173	0.040

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	1.94968	0.40261	0.14737	2.35229	0.54998	2.49966	2.90227	2.426	0.674
R2	79550	1465700	3.89721	0.45833	0.17671	4.35554	0.63504	4.53225	4.99058	4.444	0.773
R3	79550	1466300	3.15714	0.49951	0.19595	3.65665	0.69546	3.8526	4.35211	3.755	0.845
R4	78000	1465000	1.56832	0.27067	0.07867	1.83899	0.34934	1.91766	2.18833	1.878	0.438
R5	80000	1465000	1.71641	0.34593	0.09142	2.06234	0.43735	2.15376	2.49969	2.108	0.554
R6	80000	1467000	1.55608	0.26113	0.07769	1.81721	0.33882	1.8949	2.15603	1.856	0.424
R7	78000	1467000	1.53332	0.27649	0.07779	1.80981	0.35428	1.8876	2.16409	1.849	0.446

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.36114	0.05075	0.01998	0.41189	0.07073	0.43187	0.48262	0.422	0.086
2nd Highest	79550	1466300	0.34399	0.05041	0.01872	0.3944	0.06913	0.41312	0.46353	0.404	0.085

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300		0.49951	0.19595		0.69547			#DIV/0!	#DIV/0!
	79550	1465700	3.89721			4.26781		4.06358	4.43419		
Dates			91022524	91010424	91010424	91022524	91010424	91022524	91022524		

Scenario 5PM **Year91**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.08683	0.01269	0.00496	0.09952	0.01765	0.10448	0.11717	0.102	0.021
R2	79550	1465700	0.36727	0.05169	0.02016	0.41896	0.07185	0.43912	0.49081	0.429	0.087
R3	79550	1466300	0.36277	0.05254	0.01947	0.41531	0.07201	0.43478	0.48732	0.425	0.088
R4	78000	1465000	0.08573	0.01401	0.00411	0.09974	0.01812	0.10385	0.11786	0.102	0.023
R5	80000	1465000	0.14009	0.02525	0.00735	0.16534	0.0326	0.17269	0.19794	0.169	0.041
R6	80000	1467000	0.19033	0.03219	0.00957	0.22252	0.04176	0.23209	0.26428	0.227	0.052
R7	78000	1467000	0.14829	0.02498	0.00745	0.17327	0.03243	0.18072	0.2057	0.177	0.041

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.21797	0.4027	0.14742	2.62067	0.55012	2.76809	3.17079	2.694	0.674
R2	79550	1465700	3.94711	0.53039	0.19215	4.4775	0.72254	4.66965	5.20004	4.574	0.886
R3	79550	1466300	3.73001	0.51909	0.17131	4.2491	0.6904	4.42041	4.9395	4.335	0.855
R4	78000	1465000	1.61211	0.27489	0.07952	1.887	0.35441	1.96652	2.24141	1.927	0.445
R5	80000	1465000	1.83295	0.36279	0.09819	2.19574	0.46098	2.29393	2.65672	2.245	0.582
R6	80000	1467000	1.74714	0.29403	0.07855	2.04117	0.37258	2.11972	2.41375	2.080	0.471
R7	78000	1467000	1.53333	0.2765	0.07779	1.80983	0.35429	1.88762	2.16412	1.849	0.446

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.36727	0.05254	0.02016	0.41981	0.0727	0.43997	0.49251	0.430	0.089
2nd Highest	79550	1466300	0.36277	0.05169	0.01947	0.41446	0.07116	0.43393	0.48562	0.424	0.087

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	3.94711	0.53039	0.19215	4.32075	0.72253	4.1147	4.48833		
Dates			91022524	91022524	91022524	91022524	91022524	91022524	91022524		

Scenario 6PM   Year 91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.08573	0.01321	0.0051	0.09894	0.01831	0.10404	0.11725	0.101	0.022
R2	79550	1465700	0.36653	0.05264	0.0202	0.41917	0.07284	0.43937	0.49201	0.429	0.089
R3	79550	1466300	0.39653	0.05929	0.02169	0.45582	0.08098	0.47751	0.5368	0.467	0.099
R4	78000	1465000	0.07823	0.01279	0.00373	0.09102	0.01652	0.09475	0.10754	0.093	0.021
R5	80000	1465000	0.14244	0.0253	0.00743	0.16774	0.03273	0.17517	0.20047	0.171	0.041
R6	80000	1467000	0.1973	0.0331	0.00984	0.2304	0.04294	0.24024	0.27334	0.235	0.054
R7	78000	1467000	0.14985	0.02511	0.00751	0.17496	0.03262	0.18247	0.20758	0.179	0.041

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.21798	0.38316	0.11778	2.60114	0.50094	2.71892	3.10208	2.660	0.625
R2	79550	1465700	3.95021	0.52327	0.1899	4.47348	0.71317	4.66338	5.18665	4.568	0.874
R3	79550	1466300	3.73003	0.5187	0.17131	4.24873	0.69001	4.42004	4.93874	4.334	0.855
R4	78000	1465000	1.61211	0.27489	0.07952	1.887	0.35441	1.96652	2.24141	1.927	0.445
R5	80000	1465000	1.79538	0.35447	0.09619	2.14985	0.45066	2.24604	2.60051	2.198	0.569
R6	80000	1467000	1.81414	0.29402	0.07995	2.10816	0.37397	2.18811	2.48213	2.148	0.472
R7	78000	1467000	1.62583	0.29434	0.08051	1.92017	0.37485	2.00068	2.29502	1.960	0.473

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.39653	0.05929	0.02169	0.45582	0.08098	0.47751	0.5368	0.467	0.099
2nd Highest	79550	1466300	0.36653	0.05264	0.0202	0.41917	0.07284	0.43937	0.49201	0.429	0.089

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	3.95021	0.52327	0.1899	4.324	0.71316	4.11786	4.49165	4.221	0.383
Dates			91022524	91022524	91022524	91022524	91022524	91022524	91022524		

Scenario 7PM **Year 91**

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.08818	0.01406	0.00528	0.10224	0.01934	0.10752	0.12158	0.105	0.024
R2	79550	1465700	0.36442	0.05333	0.02027	0.41775	0.0736	0.43802	0.49135	0.428	0.090
R3	79550	1466300	0.41918	0.06326	0.0228	0.48244	0.08606	0.50524	0.5685	0.494	0.106
R4	78000	1465000	0.07255	0.01222	0.00354	0.08477	0.01576	0.08831	0.10053	0.087	0.020
R5	80000	1465000	0.13729	0.02426	0.00714	0.16155	0.0314	0.16869	0.19295	0.165	0.039
R6	80000	1467000	0.20101	0.03402	0.01007	0.23503	0.04409	0.2451	0.27912	0.240	0.055
R7	78000	1467000	0.14413	0.02423	0.00722	0.16836	0.03145	0.17558	0.19981	0.172	0.039

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.21756	0.37931	0.11582	2.59687	0.49513	2.71269	3.092	2.655	0.618
R2	79550	1465700	3.95021	0.45892	0.18119	4.40913	0.64011	4.59032	5.04924	4.500	0.777
R3	79550	1466300	4.04289	0.5998	0.19554	4.64269	0.79534	4.83823	5.43803	4.740	0.987
R4	78000	1465000	1.88898	0.33103	0.09459	2.22001	0.42562	2.3146	2.64563	2.267	0.535
R5	80000	1465000	1.76935	0.34851	0.09479	2.11786	0.4433	2.21265	2.56116	2.165	0.560
R6	80000	1467000	1.66287	0.29973	0.09488	1.9626	0.39461	2.05748	2.35721	2.010	0.491
R7	78000	1467000	1.74193	0.32034	0.08526	2.06227	0.4056	2.14753	2.46787	2.105	0.513

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.41918	0.06326	0.0228	0.48244	0.08606	0.50524	0.5685	0.494	0.106
2nd Highest	79550	1466300	0.36442	0.05333	0.02027	0.41775	0.0736	0.43802	0.49135	0.428	0.090

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.04289c	.59980c	.19554c	4.54125c	.79534c	4.20009c	4.69845c		
Dates			91112824	91052724	91052724	91112824	91052724	91112824	91112824		

Scenario 8PM Year 91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.09334	0.01537	0.00553	0.10871	0.0209	0.11424	0.12961	0.111	0.026
R2	79550	1465700	0.3575	0.05249	0.01974	0.40999	0.07223	0.42973	0.48222	0.420	0.088
R3	79550	1466300	0.4357	0.067	0.0239	0.5027	0.0909	0.5266	0.5936	0.515	0.112
R4	78000	1465000	0.07489	0.01296	0.00373	0.08785	0.01669	0.09158	0.10454	0.090	0.021
R5	80000	1465000	0.13498	0.02393	0.00701	0.15891	0.03094	0.16592	0.18985	0.162	0.039
R6	80000	1467000	0.20787	0.03529	0.01035	0.24316	0.04564	0.25351	0.2888	0.248	0.057
R7	78000	1467000	0.13453	0.0226	0.00671	0.15713	0.02931	0.16384	0.18644	0.160	0.037

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.64519	0.38732	0.11812	3.03251	0.50544	3.15063	3.53795	3.092	0.631
R2	79550	1465700	3.61005	0.45892	0.18119	4.06897	0.64011	4.25016	4.70908	4.160	0.777
R3	79550	1466300	4.64795	0.5998	0.19554	5.24775	0.79534	5.44329	6.04309	5.346	0.987
R4	78000	1465000	2.13127	0.3844	0.10932	2.51567	0.49372	2.62499	3.00939	2.570	0.621
R5	80000	1465000	1.46925	0.28738	0.07891	1.75663	0.36629	1.83554	2.12292	1.796	0.462
R6	80000	1467000	1.68325	0.28525	0.08638	1.9685	0.37163	2.05488	2.34013	2.012	0.464
R7	78000	1467000	1.74208	0.32038	0.08527	2.06246	0.40565	2.14773	2.46811	2.105	0.513

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1465700	0.4357	0.067	0.0239	0.5027	0.0909	0.5266	0.5936	0.515	0.112
2nd Highest	79550	1466300	0.3575	0.05249	0.01974	0.40999	0.07223	0.42973	0.48222	0.420	0.088

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	4.64795c	.59980c	.19554c	5.20124c	.79534c	4.82078c	5.37406c		
Dates			91112824	91052724	91052724	91112824	91052724	91112824	91112824		

Scenario 9PM Year 91

Annual Average Concentrations in ug/m^3

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
R1	78400	1465800	0.11346	0.01918	0.00668	0.13264	0.02586	0.13932	0.1585	0.136	0.032
R2	79550	1465700	0.36647	0.05486	0.0203	0.42133	0.07516	0.44163	0.49649	0.431	0.092
R3	79550	1466300	0.46052	0.07128	0.02518	0.5318	0.09646	0.55698	0.62826	0.544	0.119
R4	78000	1465000	0.07393	0.01273	0.00363	0.08666	0.01636	0.09029	0.10302	0.088	0.021
R5	80000	1465000	0.13305	0.02356	0.0069	0.15661	0.03046	0.16351	0.18707	0.160	0.038
R6	80000	1467000	0.20538	0.03492	0.01017	0.2403	0.04509	0.25047	0.28539	0.245	0.057
R7	78000	1467000	0.12884	0.02165	0.00643	0.15049	0.02808	0.15692	0.17857	0.154	0.035

First Highest Concentrations in ug/m^3

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
R1	78400	1465800	2.71865	0.38724	0.11807	3.10589	0.50531	3.22396	3.6112	3.165	0.631
R2	79550	1465700	3.30147	0.47999	0.18832	3.78146	0.66831	3.96978	4.44977	3.876	0.812
R3	79550	1466300	5.27154	0.63043	0.19691	5.90197	0.82734	6.09888	6.72931	6.000	1.031
R4	78000	1465000	2.13129	0.3844	0.10932	2.51569	0.49372	2.62501	3.00941	2.570	0.621
R5	80000	1465000	1.32297	0.25932	0.07118	1.58229	0.3305	1.65347	1.91279	1.618	0.417
R6	80000	1467000	1.51056	0.27755	0.08638	1.78811	0.36393	1.87449	2.15204	1.831	0.454
R7	78000	1467000	1.74213	0.32039	0.08527	2.06252	0.40566	2.14779	2.46818	2.105	0.513

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
1st Highest	79550	1466300	0.46052	0.07128	0.02518	0.5318	0.09646	0.4857	0.55698	0.462	0.135
2nd Highest	79550	1465700	0.36647	0.05486	0.0203	0.42133	0.07516	0.38677	0.44163	0.451	0.013

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	*x*	*y*	*Line 1*	*Line 2*	*Line 3*	*Line 12*	*Line23*	*Line 13*	*Line123*	*Mean*	*STDV*
1st Highest	79550	1466300	5.27154c	.63043c	.19691c	5.90197c	.82734c	5.46845c	6.09888c		
Dates			91112824	91112824	91112824	91112824	91112824	91112824	91112824		

Scenario 10PM Year 91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.13255	0.02271	0.00777	0.15526	0.03048	0.16303	0.18574	0.159	0.038
R2	79550	1465700	0.37758	0.05676	0.02082	0.43434	0.07758	0.45516	0.51192	0.445	0.095
R3	79550	1466300	0.47627	0.07521	0.02626	0.55148	0.10147	0.57774	0.65295	0.565	0.125
R4	78000	1465000	0.07418	0.01283	0.00363	0.08701	0.01646	0.09064	0.10347	0.089	0.021
R5	80000	1465000	0.13581	0.02407	0.00704	0.15988	0.03111	0.16692	0.19099	0.163	0.039
R6	80000	1467000	0.21475	0.03669	0.01065	0.25144	0.04734	0.26209	0.29878	0.257	0.059
R7	78000	1467000	0.12523	0.02097	0.00624	0.1462	0.02721	0.15244	0.17341	0.149	0.034

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.71865	0.47627	0.14753	3.19492	0.6238	3.34245	3.81872	3.269	0.778
R2	79550	1465700	3.29287	0.48	0.18832	3.77287	0.66832	3.96119	4.44119	3.867	0.812
R3	79550	1466300	5.27965	0.63659	0.20029	5.91624	0.83688	6.11653	6.75312	6.016	1.042
R4	78000	1465000	2.13129	0.3844	0.10932	2.51569	0.49372	2.62501	3.00941	2.570	0.621
R5	80000	1465000	1.3087	0.24245	0.0692	1.55115	0.31165	1.62035	1.8628	1.586	0.392
R6	80000	1467000	1.59222	0.27755	0.08638	1.86977	0.36393	1.95615	2.2337	1.913	0.454
R7	78000	1467000	1.74214	0.32039	0.08527	2.06253	0.40566	2.1478	2.46819	2.105	0.513

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	0.47627	0.07521	0.02626	0.55148	0.10147	0.57774	0.65295	0.565	0.125
2nd Highest	79550	1465700	0.37758	0.05676	0.02082	0.43434	0.07758	0.45516	0.51192	0.445	0.095

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	5.27965c	.63659c	.20029c	5.91624c	.83688c	5.47995c	6.11653c		
Dates			91112824	91112824	91112824	91112824	91112824	91112824	91112824		

Scenario 11PM Year91

Annual Average Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	0.14352	0.02465	0.00839	0.16817	0.03304	0.17656	0.20121	0.172	0.041
R2	79550	1465700	0.37267	0.05681	0.02065	0.42948	0.07746	0.45013	0.50694	0.440	0.095
R3	79550	1466300	0.49111	0.07742	0.0268	0.56853	0.10422	0.59533	0.67275	0.582	0.128
R4	78000	1465000	0.07705	0.01339	0.00377	0.09044	0.01716	0.09421	0.1076	0.092	0.022
R5	80000	1465000	0.13919	0.0248	0.00722	0.16399	0.03202	0.17121	0.19601	0.168	0.040
R6	80000	1467000	0.21266	0.03635	0.0105	0.24901	0.04685	0.25951	0.29586	0.254	0.059
R7	78000	1467000	0.12815	0.02143	0.00637	0.14958	0.0278	0.15595	0.17738	0.153	0.035

First Highest Concentrations in ug/m^3

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
R1	78400	1465800	2.71865	0.47395	0.14628	3.1926	0.62023	3.33888	3.81283	3.266	0.774
R2	79550	1465700	3.29287	0.48	0.18832	3.77287	0.66832	3.96119	4.44119	3.867	0.812
R3	79550	1466300	5.27965	0.66028	0.20726	5.93993	0.86754	6.14719	6.80747	6.044	1.080
R4	78000	1465000	2.12977	0.38431	0.10931	2.51408	0.49362	2.62339	3.0077	2.569	0.621
R5	80000	1465000	1.3087	0.24245	0.06921	1.55115	0.31166	1.62036	1.86281	1.586	0.392
R6	80000	1467000	1.59222	0.27755	0.08638	1.86977	0.36393	1.95615	2.2337	1.913	0.454
R7	78000	1467000	1.86275	0.32039	0.096	2.18314	0.41639	2.27914	2.59953	2.231	0.521

THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	0.49111	0.07742	0.0268	0.56853	0.10422	0.59533	0.67275	0.582	0.128
2nd Highest	79550	1465700	0.37267	0.05681	0.02065	0.42948	0.07746	0.45013	0.50694	0.440	0.095

THE SUMMARY OF HIGHEST 24-HR RESULTS

Receptor ID	x	y	Line 1	Line 2	Line 3	Line 12	Line23	Line 13	Line123	Mean	STDV
1st Highest	79550	1466300	5.27965c	.66028c	.20726c	5.91624c	.86754c	5.47995c	6.11653c		
Dates			91112824	91051124	91051124	91112824	91051124	91112824	91112824		

APPENDIX H

Appendix H

Selected Exposure Factor Studies

1.0 INTRODUCTION

Table 1 Body Weight of Adults[a] (kilograms)

Age (years)	Men		Women		Men and Women
	Mean (kg)	Std. Dev.	Mean (kg)	Std. Dev.	Mean (kg)
18-25	73.8	12.7	60.6	11.9	67.2
25-35	78.7	13.7	64.2	15.0	71.5
35-45	80.9	13.4	67.1	15.2	74.0
45-55	80.9	13.6	68.0	15.3	74.5
55-65	78.8	12.8	67.9	14.7	73.4
65-75	74.8	12.8	66.6	13.8	70.7
18-75	78.1	13.5	65.4	14.6	71.8

Note: 1kg = 2.2046 lb
[a] Includes clothing weight, estimated as ranging from .09 to .28 kg
Percentile data provided in Appendix A (A-1 and A-2)
Source: Adapted from National Center for Health Statistics (NCHS), 1987

Two parameters which are widely used in exposure assessment, relatively constant throughout the general population and have been the subject of numerous studies of reasonable quality are: body weight (BW) and inhalation rate (IR). The EPA's standard assumptions for body weight and inhalation rate are 70 kg and 20 m^3/day, respectively. These values may be inaccurate for the national population and may be inappropriate for the sub-populations under consideration.[1]

The purpose of this report is to provide additional choices and considerations for selecting body weight and inhalation values for use in probability distributions. This will allow the reader to develop a critical viewpoint based on a compilation of relevant facts.

2.0 BODY WEIGHT

The body weight of individuals is not expected to vary significantly from setting to setting. For this reason, one would suspect a standard distribution to be derived quite easily. Several distributions have been developed based on the enormous amounts of body weight data published by the US Public Health Service. The following body weight studies utilized data taken from the second National Health and Nutrition Examination Survey (NHANES II), conducted from February 1976 through February 1980. This survey represents the most comprehensive and reliable data set for body weight in the United States.[2]

Study 1

This study consisted of 20,322 subjects, based on a civilian non-institutionalized population aged 6 months to 75 years. Ultimately this study results in the normal distributions summarized in Tables 1 and 2.

Table 2 Body Weight of Children[a] (kilograms)

Age	Boys		Girls		Boys and Girls
	Mean (kg)	Std. Dev.	Mean (kg)	Std. Dev.	Mean (kg)
6-11 months	9.4	1.3	8.8	1.2	9.1
1 year	11.8	1.9	10.8	1.4	11.3
2 years	13.6	1.7	13.0	1.5	13.3
3 years	15.7	2.0	14.9	2.1	15.3
4 years	17.8	2.5	17.0	2.4	17.4
5 years	19.8	3.0	19.6	3.3	19.7
6 years	23.0	4.0	22.1	4.0	22.6
7 years	25.1	3.9	24.7	5.0	24.9
8 years	28.2	6.2	27.9	5.7	28.1
9 years	31.1	6.3	31.9	8.4	31.5
10 years	36.4	7.7	36.1	8.0	36.3
11 years	40.3	10.1	41.8	10.9	41.1
12 years	44.2	10.1	46.4	10.1	45.3
13 years	49.9	12.3	50.9	11.8	50.4
14 years	57.1	11.0	54.8	11.1	56.0
15 years	61.0	11.0	55.1	9.8	58.1
16 years	67.1	12.4	58.1	10.1	62.6
17 years	66.7	11.5	59.6	11.4	63.2
18 years	71.1	12.7	59.0	11.1	65.1
19 years	71.7	11.6	60.2	11.0	66.0

Note: 1kg = 2.2046 lb

[a] Includes clothing weight, estimated as ranging from .09 to .28 kg

Percentile data provided in Appendix A (A-3 and A-4)

Source: Adapted from National Center for Health Statistics (NCHS), 1988

Examination of Table 1 shows a mean body weight of 71.8 kg (for adult men and women combined). This closely compares to the 70 kg EPA assumption. Overall, this study is given a high order of confidence by the US EPA. It is recommended for use, due to high peer review of the NHANES II source data, large sample size (28,000 persons), lack of bias, and low measurement error.

Study 2[2]

The second study focuses on persons less than 18 years of age, due to the greatest variance in body weight existing within this group. Burmaster, examined a group of 4,079 females and 4,379 males between the ages of 6 months and 20 years, extracted from the NHANES II data. The data employed was statistically adjusted for non-response and probability of selection, as well as stratified by age, sex and race to reflect the entire United States population prior to reporting. Burmaster et. al. (1994) found that lognormal distributions give strong fits to body weight for persons between 6 months and 20 years.[1] Corresponding statistics for the lognormal probability plots are presented in Table 3.

This particular study is listed by the EPA as a relevant alternative information source on body weights and is believed to give a good approximation for a young subject group.

Table 3 Statistics for Probability Plot Regression Analysis

Age	Male		Female	
	Mean[a] (kg)	Std. Dev.[a]	Mean[a] (kg)	Std. Dev.[a]
6 months - 1 year	2.23	0.132	2.16	0.145
1 to 2 years	2.46	0.119	2.38	0.128
2 to 3 years	2.60	0.120	2.56	0.112
3 to 4 years	2.75	0.114	2.69	0.137
4 to 5 years	2.87	0.133	2.83	0.133
5 to 6 years	2.99	0.138	2.98	0.163
6 to 7 years	3.13	0.145	3.10	0.174
7 to 8 years	3.21	0.151	3.19	0.174
8 to 9 years	3.33	0.181	3.31	0.156
9 to 10 years	3.43	0.165	3.46	0.214
10 to 11 years	3.59	0.195	3.57	0.199
11 to 12 years	3.69	0.252	3.71	0.226
12 to 13 years	3.78	0.224	3.82	0.213
13 to 14 years	3.88	0.215	3.92	0.216
14 to 15 years	4.02	0.181	3.99	0.187
15 to 16 years	4.09	0.159	4.00	0.156
16 to 17 years	4.20	0.168	4.06	0.167
17 to 18 years	4.19	0.167	4.08	0.165
18 to 19 years	4.25	0.159	4.07	0.147
19 to 20 years	4.26	0.154	4.10	0.149

Note: 1kg = 2.2046 lb

[a] Mean, Std. Dev. - correspond to the mean and standard deviation of the lognormal distribution of body weight (kg).

Source: Burmaster et al., 1994.

3.0 INHALATION RATE

Breathing rates (inhalation rates) are dependent on various individual characteristics, including: age, gender, weight, level of health and degree of activity. Since inhalation rates are unlikely to be influenced by site-specific conditions, standard distributions should be appropriate. The inhalation studies discussed in the following pages, present several interpretations based on different choices of individual characteristics for a population.

Study 1

This study utilizes measured values gathered by the US EPA (1985) for inhalation rates based on various age and gender categories from early studies. The data was compiled at multiple activity levels as summarized in Table 4. Activity patterns (hours spent at a particular activity) were determined for three microenvironments by activity level for all age groups (Table 5). From the data presented in Tables 4 and 5, daily inhalation rates were calculated using a time-activity ventilation approach. These rates are summarized in Table 6.

Table 4 Summary of Human Inhalation Rates for Men, Women and Children by Activity Level (m^3/hr)[a]

	n[b]	Resting[c]	n	Light[d]	n	Moderate[e]	n	Heavy[f]
Adult Male	454	0.7	102	0.8	102	2.5	267	4.8
Adult Female	595	0.3	786	0.5	106	1.6	211	2.9
Average Adult	–	0.5	–	0.6	–	2.1	–	3.9
Child, age 6	8	0.4	16	0.8	4	2	5	2.3
Child, age 10	10	0.4	40	1	29	3.2	43	3.9

[a] Values of inhalation rates for males, females and children(male and female) presented in this table represent the mean of values reported for each activity level in 1985. (See Appendix B (B-1) for a detailed listing of the data from U.S. EPA, 1985.)

[b] n = number of observations at each activity level.

[c] Includes watching television, reading and sleeping

[d] Includes most domestic work, attending to personal needs and care, hobbies and conducting minor indoor repairs and home improvements.

[e] Includes heavy indoor cleanup, performance of major indoor repairs and alterations and climbing stairs.

[f] Includes vigorous physical exercise and climbing stairs carrying a load.

Source: Adapted from U.S. EPA, 1985.

The main limitation of this study arises due to values based on early studies. The US EPA neglects to discuss the accuracy and validity of the values used. This introduces a degree of uncertainty. Actual measurements taken for a large number of subjects and data presented for both adults and children are among the advantages.

Table 5 Activity Pattern Data For All Age Groups

Microenvironment	Activity Level	Average Hours Per Day in Each Microenvironment at Each Activity Level
Indoors	Resting	9.82
	Light	9.82
	Moderate	0.71
	Heavy	0.098
	TOTAL	20.4
Outdoors	Resting	0.505
	Light	0.505
	Moderate	0.65
	Heavy	0.12
	TOTAL	1.77
In Transportation Vehicle	Resting	0.86
	Light	0.86
	Moderate	0.05
	Heavy	0.0012
	TOTAL	1.77

Source: Adapted from U.S. EPA, 1985.

Table 6 Summary of Daily Inhalation Rates Grouped By Age and Activity Level

Subject	Daily Inhalation Rate (m^3/day)[a] Resting	Light	Moderate	Heavy	Total Daily IR[b] (m^3/day)
Adult Male	7.83	8.95	3.53	1.05	21.40
Adult Female	3.35	5.59	2.26	0.64	11.80
Adult Average	5.60	6.71	2.96	0.85	16.00
Child (Age 6)	4.47	8.95	2.82	0.50	16.74
Child (Age 10)	4.47	11.19	4.51	0.85	21.02

[a] In this table, inhalation rate was calculated by using the following equation:

$$IR = \frac{1}{T}\sum_{i=1}^{k} IR_i t_i$$

where: IR_i = inhalation rate at ith activity (Table 4)
t_i = hours spent per day during ith activity (Table 5)
k = number of activity periods
T = total time of the exposure period (e.g., a day)

[b] Total daily inhalation rate was calculated by summing the individual daily inhalation rate

Source: Generated using data from Tables 4 and 5.

Study 2

The International Commission on Radiological Protection (ICRP) also estimated daily inhalation rates for all ages and genders using a time-activity ventilation approach. Using compiled reference values for inhalation rates from various sources (Appendix B), the ICRP preceded by assuming the hours spent for various age and gender categories within specific activities (described in Table 7 footnotes). Table 7 presents the results of this study.

The obvious limitation of this study lies within the accuracy and validity of employed inhalation data. Assuming the hours spent in specific

Table 7 Daily Inhalation Rates Estimated From Daily Activities[a]

Subject	Inhalation Rate (IR) Resting (m^3/hr)	Light (m^3/hr)	Daily IR[b] (m^3/day)
Adult Male	0.45	1.20	22.80
Adult Female	0.36	1.14	21.10
Adult Average	--	--	21.95
Child (10 years)	0.29	0.78	14.80
Infant (1 year)	0.09	0.25	3.76
Newborn	0.03	0.09	0.78

[a] Assumptions made were based on 8 hours resting and 16 hours light activity for adults and children (10 yrs); 14 hours resting and 10 hours light activity for infants (1 yr); 23 hours resting and 1 hour light activity for newborns. Compiled reference values in Appendix B(B-2).

[b]

$$IR = \frac{1}{T}\sum_{i=1}^{k} IR_i t_i$$

where: IR_i = inhalation rate at ith activity
t_i = hours spent per day during ith activity
k = number of activity periods
T = total time of the exposure period (i.e., a day)

Source: International Commission on Radiological Protection (ICRP), 1981.

activities may also limit this study's precision. Overall, these assumptions may over or under-estimate calculated inhalation rates. Therefore, this approach poses a large degree of uncertainty.

Study 3

The Exposure Assessment Group (EAG) of the EPA's Office of Research and Development conducted a study on ventilation rates between March 1984 and January 1985. For each age-sex activity level for which data were available, minimum, maximum and mean rates were determined. Some values were presented without minimum and maximum values from the original data, making them representative only of available individual measurements.[4] Table 8 summarizes the ventilation ranges determined by the EAG.

Table 8 Ventilation Ranges By Age, Sex and Activity Level

Age	Sex	Ventilation Ranges (m^3/hr)											
		Resting			Light			Moderate			Heavy		
		Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Adults													
	Female	0.25*	0.70	0.34	0.25*	1.76	0.49	1.24*	2.05*	0.16	1.40*	6.89	2.87
	Male	0.14	1.13*	0.73	0.14	1.66*	0.83	0.86	4.68	2.45	2.08	11.00	4.80
* Mean value – actual may fall above or below these values													

Some of the values in Table 8 are marked as means, indicating that the true minimum or maximum for the group may lie outside the value given. This presents a large amount of uncertainty and potential error in final inhalation calculations. Inhalation rates may be calculated by choosing times spent at each activity level, similar to that summarized in Table 5.

This study is included to allow experiment with assigning data, such as that in Table 8, to a triangular distribution. Typically triangular distributions are used as a conservative estimate of the actual distribution, taking into account large amounts of uncertainty in available data.[3]

Summary Of EPA Recommendations

The EPA (1989) summarizes the recommended inhalation rate values in Table 9. The values for males and females differ slightly from the EPA's original 20 m^3/day assumption. These recommendations consider many key studies, including some discussed in this report. As in all cases, assessors are encouraged to use values which most accurately reflect the population in question.

4.0 CONCLUSION

The application of Monte Carlo analyses to environmental health risk assessment is far from routine. One of the primary obstacles of probabilistic modeling is the lack of consensus on proper distributions to use for key exposure factors.[3] This report focused lightly on two exposure factors (body weight and inhalation rate) along with some relevant studies. Body weight values were shown to fall between 70 and 72 kilograms for adults, suggesting consistency among studies. Inhalation rates ranged from 11.3 to 21 m^3/day for females and from 15.2 to 23 m^3/day for males, posing a sensitive outcome based on distribution selection. Due to the large numbers of studies, the risk assessor must make critical decisions as to which distribution best represents the population in question. In some cases a "best guess" may have to be employed where data is limited and unavailable.

The purpose of EPA's Risk Assessment Handbooks is to provide users with acceptable distributions for exposure factors, applicable to a general population. In most cases, the recommended distribution contains a high level of confidence based on peer review. Risk assessors should use caution when adopting these distributions. Typically they are grossly generalized for a large population.

Table 9 Summary of Recommended Values for Inhalation

Population	Mean
Long-term exposures	4.5 m^3/day
Children (1 year)	
Children (1-12 years)	8.7 m^3/day
Adults	
Males	15.2 m^3/day
Females	11.3 m^3/day
Short-term exposures	
Adults and Children	
Rest	0.3 m^3/hr
Sedentary Activities	0.4 m^3/hr
Light Activities	1.0 m^3/hr
Moderate Activities	1.2 m^3/hr
Heavy Activities	1.9 m^3/hr
Outdoor Workers	
Hourly Average	1.3 m^3/hr
Slow Activities	1.1 m^3/hr
Moderate Activities	1.5 m^3/hr
Heavy Activities	2.3 m^3/hr
Source: EPA Exposure Factors Handbook, Volume I, General Factors, May 1989.	

The goal of this report was to provide the decision maker with an opportunity to see the wealth of studies on probability distribution characterizations as an option to:[5]

- Increase flexibility
- Consider more possibilities and;
- Provide alternatives which might not be allowed or feasible if the risk characterization was a "bright line" or "single number".

REFERENCES

1. US EPA (May 1989). Exposure Factors Handbook, Volume 1 of 3, General Factors, Washington DC., EPA.

2. Burmaster, D.E.; Lloyd, K.J.; Crouch, E.A.C., "Lognormal Distributions of Body Weight as a Function of Age For Female and Male Children In The US", 1994.

3. Finley, Brent; Proctor, Deborah; Scott, Paul; Harrinton, Natalie; Paustenbach, Dennis; Price, Paul, "Recommended Distributions for Exposure Factors Frequently Used in Health Risk Assessment", Risk Analysis, Vol. 14, No. 4, 1994.

4. Anderson, E.; Browne, N.; Duletsky, S.; Ramig, J.; and Warn, T., "Devolopment of Statistical Distributions or Ranges of Standard Factors Used In Exposure Assessments", Office of Health and Environmental Assessment, US EPA, Washington D.C., 1985.

5. Haimes, Yacov Y.; Barry, Timothy; and Lambert, James H., "When and How Can You Specify a Probabiltiy Distribution When You Don't Know Much?", Risk Analysis, Vol. 14, No. 5, 1994.

APPENDIX I

Intake Results from Selected Chemicals for all Binders

RisMode The @RISK Model :
Human Health Risk Analysis
1987-1991

Intake = (CA)x(IR)x(ET)x(EF)x(ED) / (BW)x(AT)

Benzene Concentrations and Intakes at Receptor R1

HAP Conc. in Air C_{air}, ug/m3	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
	1987	3.14	3.14	3.13	1.96	3.25	3.07	3.07	3.07	3.69	3.08	3.07	3.07	3.07	3.07	3.07	3.03	3.03
	1988	3.48	3.79	3.79	3.33	3.74	3.74	3.20	2.55	2.54	2.35	2.13	2.24	2.88	3.01	3.20	3.38	3.94
	1989	4.59	4.59	4.59	3.45	3.45	2.29	2.25	2.23	2.39	2.39	2.39	2.41	2.55	2.69	2.69	2.90	3.65
	1990	4.54	4.54	4.53	4.38	4.36	4.00	3.80	3.80	2.50	2.46	1.82	1.88	1.86	2.28	2.28	2.30	2.98
	1991	3.16	3.00	2.68	1.87	3.05	3.05	3.39	2.80	2.82	2.43	2.69	2.66	2.65	3.09	3.16	3.27	3.27
HAP Intake, ug/kg-day	**Period**	**7AM**	**8AM**	**9AM**	**10AM**	**11AM**	**12PM**	**1PM**	**2PM**	**3PM**	**4PM**	**5PM**	**6PM**	**7PM**	**8PM**	**9PM**	**10PM**	**11PM**
	1987	0.21	0.21	0.21	0.13	0.22	0.21	0.21	0.21	0.25	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.20
	1988	0.23	0.25	0.25	0.22	0.25	0.25	0.21	0.17	0.17	0.16	0.14	0.15	0.19	0.20	0.22	0.23	0.26
Child	1989	0.31	0.31	0.31	0.23	0.23	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.17	0.18	0.18	0.19	0.25
	1990	0.30	0.30	0.30	0.29	0.29	0.27	0.26	0.26	0.17	0.17	0.12	0.13	0.12	0.15	0.15	0.15	0.20
	1991	0.21	0.20	0.18	0.13	0.20	0.20	0.23	0.19	0.19	0.16	0.18	0.18	0.18	0.21	0.21	0.22	0.22
	Period	**7AM**	**8AM**	**9AM**	**10AM**	**11AM**	**12PM**	**1PM**	**2PM**	**3PM**	**4PM**	**5PM**	**6PM**	**7PM**	**8PM**	**9PM**	**10PM**	**11PM**
	1987	2.03	2.03	2.02	1.26	2.10	1.98	1.98	1.98	2.38	1.99	1.98	1.98	1.98	1.98	1.98	1.96	1.96
	1988	2.25	2.45	2.45	2.15	2.42	2.42	2.07	1.64	1.64	1.52	1.37	1.45	1.86	1.95	2.07	2.18	2.55
Women	1989	2.97	2.97	2.97	2.23	2.23	1.48	1.46	1.44	1.54	1.54	1.54	1.56	1.65	1.74	1.74	1.87	2.36
	1990	2.93	2.93	2.93	2.83	2.82	2.59	2.46	2.46	1.61	1.59	1.18	1.21	1.20	1.47	1.47	1.48	1.93
	1991	2.04	1.94	1.73	1.21	1.97	1.97	2.19	1.81	1.82	1.57	1.74	1.72	1.72	2.00	2.04	2.11	2.11
	Period	**7AM**	**8AM**	**9AM**	**10AM**	**11AM**	**12PM**	**1PM**	**2PM**	**3PM**	**4PM**	**5PM**	**6PM**	**7PM**	**8PM**	**9PM**	**10PM**	**11PM**
	1987	1.69	1.69	1.68	1.05	1.75	1.65	1.65	1.65	1.98	1.65	1.65	1.65	1.65	1.65	1.65	1.63	1.63
	1988	1.87	2.04	2.04	1.79	2.01	2.01	1.72	1.37	1.37	1.26	1.14	1.20	1.55	1.62	1.72	1.81	2.12
Men	1989	2.47	2.47	2.47	1.85	1.85	1.23	1.21	1.20	1.28	1.28	1.28	1.29	1.37	1.44	1.44	1.56	1.96
	1990	2.44	2.44	2.43	2.35	2.34	2.15	2.04	2.04	1.34	1.32	0.98	1.01	1.00	1.23	1.23	1.23	1.60
	1991	1.70	1.61	1.44	1.00	1.64	1.64	1.82	1.50	1.51	1.30	1.45	1.43	1.43	1.66	1.70	1.75	1.75

RisMode The @RISK Model :
Human Health Risk Analysis
1987-1991

Intake = (CA)x(IR)x(ET)x(EF)x(ED) / (BW)x(AT)

Benzene Concentrations and Intakes at Receptor R2

HAP Conc. in Air C_{air}, ug/m^3

Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
1987	4.47	4.47	4.48	2.51	3.86	4.33	4.65	4.98	4.98	5.05	4.56	4.63	4.61	4.22	4.24	4.21	4.86
1988	6.14	5.55	5.22	3.89	5.54	5.04	5.02	4.90	4.80	4.42	4.02	3.81	4.03	4.08	4.38	4.48	4.55
1989	5.10	5.10	4.93	4.38	4.05	4.05	4.52	4.31	4.34	3.85	3.69	4.26	4.05	3.81	3.96	3.69	3.86
1990	5.03	5.03	5.03	5.03	5.03	4.77	4.68	4.68	4.68	4.16	3.74	3.62	4.14	4.86	5.40	5.84	5.97
1991	4.92	5.06	4.38	2.83	4.22	3.88	3.76	3.91	4.39	4.44	4.57	4.57	4.50	4.16	3.88	3.87	3.87

HAP Intake, ug/kg-day

Child

Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
1987	0.36	0.36	0.36	0.20	0.31	0.34	0.37	0.40	0.40	0.40	0.36	0.37	0.37	0.33	0.34	0.33	0.39
1988	0.49	0.44	0.41	0.31	0.44	0.40	0.40	0.39	0.38	0.35	0.32	0.30	0.32	0.32	0.35	0.36	0.36
1989	0.40	0.40	0.39	0.35	0.32	0.32	0.36	0.34	0.34	0.31	0.29	0.34	0.32	0.30	0.31	0.29	0.31
1990	0.40	0.40	0.40	0.40	0.40	0.38	0.37	0.37	0.37	0.33	0.30	0.29	0.33	0.39	0.43	0.46	0.47
1991	0.39	0.40	0.35	0.22	0.34	0.31	0.30	0.31	0.35	0.35	0.36	0.36	0.36	0.33	0.31	0.31	0.31

Women

Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
1987	2.89	2.89	2.89	1.62	2.49	2.80	3.00	3.22	3.22	3.26	2.95	2.99	2.98	2.72	2.74	2.72	3.14
1988	3.97	3.58	3.37	2.52	3.58	3.26	3.24	3.16	3.10	2.86	2.60	2.46	2.60	2.63	2.83	2.89	2.94
1989	3.29	3.29	3.19	2.83	2.62	2.62	2.92	2.78	2.80	2.49	2.39	2.76	2.62	2.46	2.56	2.38	2.49
1990	3.25	3.25	3.25	3.25	3.25	3.08	3.02	3.02	3.02	2.68	2.42	2.34	2.67	3.1	3.49	3.77	3.86
1991	3.18	3.27	2.83	1.83	2.73	2.50	2.43	2.52	2.84	2.87	2.95	2.95	2.91	2.69	2.50	2.50	2.50

Men

Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
1987	2.40	2.40	2.40	1.35	2.07	2.33	2.50	2.67	2.67	2.71	2.45	2.48	2.48	2.26	2.28	2.26	2.61
1988	3.30	2.98	2.80	2.09	2.98	2.71	2.69	2.63	2.58	2.37	2.16	2.05	2.16	2.19	2.35	2.40	2.44
1989	2.74	2.74	2.65	2.35	2.17	2.17	2.43	2.31	2.33	2.07	1.98	2.29	2.18	2.05	2.13	1.98	2.07
1990	2.70	2.70	2.70	2.70	2.70	2.56	2.51	2.51	2.51	2.23	2.01	1.95	2.22	2.61	2.90	3.13	3.21
1991	2.64	2.72	2.35	1.52	2.27	2.08	2.02	2.10	2.36	2.39	2.46	2.45	2.42	2.23	2.08	2.08	2.08

RisMode The @RISK Model :
Human Health Risk Analysis
1987-1991

Intake = (CA)x(IR)x(ET)x(EF)x(ED) / (BW)x(AT)

Benzene Concentrations and Intakes at Receptor R3

	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
HAP Conc. in Air C_{air}, ug/m^3																		
	1987	4.47	4.62	4.48	3.05	4.40	4.02	4.02	4.05	4.78	4.78	4.78	4.78	4.78	4.81	4.81	4.90	4.90
	1988	4.50	4.57	4.56	5.04	4.63	4.75	4.97	4.97	4.53	4.33	4.38	4.64	4.61	4.50	4.76	4.86	4.77
	1989	6.47	6.54	5.55	5.11	5.11	5.11	4.42	4.39	4.16	3.41	3.25	3.70	3.81	4.49	4.49	5.32	5.32
	1990	3.91	3.48	3.48	3.47	3.49	3.09	3.07	3.07	3.17	3.03	3.02	3.18	3.50	3.54	4.01	4.39	4.42
	1991	4.71	4.71	4.39	2.84	4.36	4.72	4.54	4.30	4.30	3.75	4.33	4.33	4.74	5.35	6.00	6.02	6.04
HAP Intake, ug/kg-day	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Child	1987	0.30	0.31	0.30	0.20	0.30	0.27	0.27	0.27	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.33	0.33
	1988	0.30	0.31	0.31	0.34	0.31	0.32	0.33	0.33	0.30	0.29	0.29	0.31	0.31	0.30	0.32	0.33	0.32
	1989	0.43	0.44	0.37	0.34	0.34	0.34	0.30	0.29	0.28	0.23	0.22	0.25	0.26	0.30	0.30	0.36	0.36
	1990	0.26	0.23	0.23	0.23	0.23	0.21	0.21	0.21	0.21	0.20	0.20	0.21	0.24	0.24	0.27	0.30	0.30
	1991	0.32	0.32	0.29	0.19	0.29	0.32	0.30	0.29	0.29	0.25	0.29	0.29	0.32	0.36	0.40	0.40	0.41
	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Women	1987	2.89	2.99	2.89	1.97	2.85	2.60	2.59	2.61	3.09	3.09	3.09	3.09	3.09	3.11	3.11	3.16	3.16
	1988	2.91	2.95	2.95	3.26	2.99	3.07	3.21	3.21	2.93	2.80	2.83	2.99	2.98	2.91	3.08	3.14	3.08
	1989	4.18	4.22	3.58	3.30	3.30	3.30	2.85	2.84	2.69	2.20	2.10	2.39	2.46	2.90	2.90	3.44	3.44
	1990	2.53	2.25	2.25	2.24	2.26	2.00	1.98	1.98	2.05	1.96	1.95	2.05	2.26	2.3	2.59	2.84	2.86
	1991	3.04	3.04	2.84	1.83	2.82	3.05	2.93	2.78	2.78	2.43	2.80	2.80	3.06	3.45	3.88	3.89	3.90
	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Men	1987	2.40	2.48	2.40	1.63	2.36	2.16	2.16	2.17	2.56	2.57	2.57	2.57	2.57	2.58	2.58	2.63	2.63
	1988	2.41	2.45	2.45	2.71	2.49	2.55	2.67	2.67	2.43	2.33	2.35	2.49	2.47	2.42	2.56	2.61	2.56
	1989	3.47	3.51	2.98	2.74	2.74	2.74	2.37	2.36	2.23	1.83	1.75	1.98	2.05	2.41	2.41	2.86	2.86
	1990	2.10	1.87	1.87	1.86	1.88	1.66	1.65	1.65	1.70	1.63	1.62	1.71	1.88	1.90	2.15	2.36	2.37
	1991	2.53	2.53	2.36	1.52	2.34	2.53	2.43	2.31	2.31	2.02	2.33	2.33	2.55	2.87	3.22	3.23	3.24

RisMode The @RISK Model
Human Health Risk Analysis

Intake = (CA)x(IR)x(ET)x(EF)x(ED) / (BW)x(AT)

Benzene Concentrations and Intakes from Commercial Binders at Receptor R3

Binders Designations	1991 EMF Lb/t iron	HAP Concentration in Air C_{air}, ug/m3 7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Case Study Binder	0.08410	4.71	4.71	4.39	2.84	4.36	4.72	4.54	4.30	4.30	3.75	4.33	4.33	4.74	5.35	6.00	6.02	6.04
Phenolic 'NoBake	0.67254	37.67	37.69	35.11	22.69	34.88	37.71	36.27	34.36	34.37	30.03	34.66	34.66	37.91	42.75	47.98	48.11	48.33
Phenolic 'Urethane	0.32106	17.98	17.99	16.76	10.83	16.65	18.00	17.31	16.40	16.41	14.33	16.55	16.55	18.10	20.41	22.91	22.97	23.07
Phenolic ' HotBox	0.06012	3.37	3.37	3.14	2.03	3.12	3.37	3.24	3.07	3.07	2.68	3.10	3.10	3.39	3.82	4.29	4.30	4.32
Green 'Sand	0.03666	2.05	2.05	1.91	1.24	1.90	2.06	1.98	1.87	1.87	1.64	1.89	1.89	2.07	2.33	2.62	2.62	2.63
Core Oil	0.14064	7.88	7.88	7.34	4.74	7.29	7.89	7.58	7.19	7.19	6.28	7.25	7.25	7.93	8.94	10.03	10.06	10.11
Shell	0.40002	22.40	22.42	20.89	13.49	20.74	22.43	21.57	20.44	20.44	17.86	20.62	20.62	22.55	25.43	28.54	28.62	28.75
Nitrogen Furan	0.03888	2.18	2.18	2.03	1.31	2.02	2.18	2.10	1.99	1.99	1.74	2.00	2.00	2.19	2.47	2.77	2.78	2.79
Nitrogen 'Furan-TSA	0.27204	15.24	15.24	14.20	9.18	14.11	15.25	14.67	13.90	13.90	12.15	14.02	14.02	15.33	17.29	19.41	19.46	19.55
Furan ' HotBox	0.03222	1.80	1.81	1.68	1.09	1.67	1.81	1.74	1.65	1.65	1.44	1.66	1.66	1.82	2.05	2.30	2.30	2.32
Alkyd 'Isocyanate	0.32016	17.93	17.94	16.72	10.80	16.60	17.95	17.26	16.36	16.36	14.29	16.50	16.50	18.05	20.35	22.84	22.90	23.01
Silicate-'-Ester	0.08460	4.74	4.74	4.42	2.85	4.39	4.74	4.56	4.32	4.32	3.78	4.36	4.36	4.77	5.38	6.04	6.05	6.08

Binders Designations	1991 Period	Adult HAP Intake by Inhalation, ug/kg-day 7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Case Study Binder	1	0.32	0.32	0.29	0.19	0.29	0.32	0.30	0.29	0.29	0.25	0.29	0.29	0.32	0.36	0.40	0.40	0.41
Phenolic 'NoBake	2	2.53	2.53	2.36	1.52	2.34	2.53	2.44	2.31	2.31	2.02	2.33	2.33	2.55	2.87	3.22	3.23	3.25
Phenolic 'Urethane	3	1.21	1.21	1.13	0.73	1.12	1.21	1.16	1.10	1.10	0.96	1.11	1.11	1.22	1.37	1.54	1.54	1.55
Phenolic ' HotBox	4	0.23	0.23	0.21	0.14	0.21	0.23	0.22	0.21	0.21	0.18	0.21	0.21	0.23	0.26	0.29	0.29	0.29
Green 'Sand	5	0.14	0.14	0.13	0.08	0.13	0.14	0.13	0.13	0.13	0.11	0.13	0.13	0.14	0.16	0.18	0.18	0.18
Core Oil	6	0.53	0.53	0.49	0.32	0.49	0.53	0.51	0.48	0.48	0.42	0.49	0.49	0.53	0.60	0.67	0.68	0.68
Shell	7	1.51	1.51	1.40	0.91	1.39	1.51	1.45	1.37	1.37	1.20	1.39	1.38	1.51	1.71	1.92	1.92	1.93
Nitrogen Furan	8	0.15	0.15	0.14	0.09	0.14	0.15	0.14	0.13	0.13	0.12	0.13	0.13	0.15	0.17	0.19	0.19	0.19
Nitrogen 'Furan-TSA	9	1.02	1.02	0.95	0.62	0.95	1.02	0.99	0.93	0.93	0.82	0.94	0.94	1.03	1.16	1.30	1.31	1.31
Furan ' HotBox	10	0.12	0.12	0.11	0.07	0.11	0.12	0.12	0.11	0.11	0.10	0.11	0.11	0.12	0.14	0.15	0.15	0.16
Alkyd 'Isocyanate	11	1.20	1.21	1.12	0.73	1.12	1.21	1.16	1.10	1.10	0.96	1.11	1.11	1.21	1.37	1.53	1.54	1.55
Silicate-'-Ester	12	0.32	0.32	0.30	0.19	0.29	0.32	0.31	0.29	0.29	0.25	0.29	0.29	0.32	0.36	0.41	0.41	0.41

RisMode The @RISK Model : Human Health Risk Analysis

Intake = (CA)x(IR)x(ET)x(EF)x(ED) / (BW)x(AT)

Formaldehyde Concentrations and Intakes from Commercial Binders at Receptor R3

Binders Designations	1991 EMF Lb/t iron	HAP Concentration in Air C_{air}, ug/m^3 7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Case Study Binder	**0.11160**	**6.25**	**6.25**	**5.83**	**3.76**	**5.79**	**6.26**	**6.02**	**5.70**	**5.70**	**4.98**	**5.75**	**5.75**	**6.29**	**7.09**	**7.96**	**7.98**	**8.02**
Phenolic 'NoBake	0.00060	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04
Phenolic 'Urethane	0.00132	0.07	0.07	0.07	0.04	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.08	0.09	0.09	0.09
Phenolic ' HotBox	0.00036	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Green 'Sand	0.00024	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
Core Oil	0.00576	0.32	0.32	0.30	0.19	0.30	0.32	0.31	0.29	0.29	0.26	0.30	0.30	0.32	0.37	0.41	0.41	0.41
Shell	0.00210	0.12	0.12	0.11	0.07	0.11	0.12	0.11	0.11	0.11	0.09	0.11	0.11	0.12	0.13	0.15	0.15	0.15
Nitrogen Furan	0.01602	0.90	0.90	0.84	0.54	0.83	0.90	0.86	0.82	0.82	0.72	0.83	0.83	0.90	1.02	1.14	1.15	1.15
Nitrogen 'Furan-TSA	0.00390	0.22	0.22	0.20	0.13	0.20	0.22	0.21	0.20	0.20	0.17	0.20	0.20	0.22	0.25	0.28	0.28	0.28
Furan ' HotBox	0.00054	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04
Alkyd 'Isocyanate	0.00636	0.36	0.36	0.33	0.21	0.33	0.36	0.34	0.32	0.33	0.28	0.33	0.33	0.36	0.40	0.45	0.45	0.46
Silicate-'-Ester	0.01014	0.57	0.57	0.53	0.34	0.53	0.57	0.55	0.52	0.52	0.45	0.52	0.52	0.57	0.64	0.72	0.73	0.73

Binders Designations	1991 Period	Adult HAP Intake by Inhalation, ug/kg-day 7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Case Study Binder	1	**4E-1**	**4E-1**	**4E-1**	**3E-1**	**4E-1**	**4E-1**	**4E-1**	**4E-1**	**4E-1**	**3E-1**	**4E-1**	**4E-1**	**4E-1**	**5E-1**	**5E-1**	**5E-1**	**5E-1**
Phenolic 'NoBake	2	2E-3	2E-3	2E-3	1E-3	2E-3	2E-3	2E-3	2E-3	2E-3	2E-3	2E-3	2E-3	2E-3	3E-3	3E-3	3E-3	3E-3
Phenolic 'Urethane	3	5E-3	5E-3	5E-3	3E-3	5E-3	5E-3	5E-3	5E-3	5E-3	4E-3	5E-3	5E-3	5E-3	6E-3	6E-3	6E-3	6E-3
Phenolic ' HotBox	4	1E-3	1E-3	1E-3	8E-4	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	2E-3	2E-3	2E-3	2E-3
Green 'Sand	5	9E-4	9E-4	8E-4	5E-4	8E-4	9E-4	9E-4	8E-4	8E-4	7E-4	8E-4	8E-4	9E-4	1E-3	1E-3	1E-3	1E-3
Core Oil	6	2E-2	2E-2	2E-2	1E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	3E-2	3E-2	3E-2
Shell	7	8E-3	8E-3	7E-3	5E-3	7E-3	8E-3	8E-3	7E-3	7E-3	6E-3	7E-3	7E-3	8E-3	9E-3	1E-2	1E-2	1E-2
Nitrogen Furan	8	6E-2	6E-2	6E-2	4E-2	6E-2	6E-2	6E-2	5E-2	5E-2	5E-2	6E-2	6E-2	6E-2	7E-2	8E-2	8E-2	8E-2
Nitrogen 'Furan-TSA	9	1E-2	1E-2	1E-2	9E-3	1E-2	1E-2	1E-2	1E-2	1E-2	1E-2	1E-2	1E-2	1E-2	2E-2	2E-2	2E-2	2E-2
Furan ' HotBox	10	2E-3	2E-3	2E-3	1E-3	2E-3	2E-3	2E-3	2E-3	2E-3	2E-3	2E-3	2E-3	2E-3	2E-3	3E-3	3E-3	3E-3
Alkyd 'Isocyanate	11	2E-2	2E-2	2E-2	1E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	3E-2	3E-2	3E-2	3E-2
Silicate-'-Ester	12	4E-2	4E-2	4E-2	2E-2	4E-2	4E-2	4E-2	3E-2	3E-2	3E-2	4E-2	4E-2	4E-2	4E-2	5E-2	5E-2	5E-2

RisMode The @RISK Model : Human Health Risk Analysis

Intake = (CA)x(IR)x(ET)x(EF)x(ED) / (BW)x(AT)

Phenol Concentrations and Intakes from Commercial Binders at Receptor R3

Binders Designations	1991 EMF Lb/t iron	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		HAP Concentration in Air C_{air}, ug/m3																
Case Study Binder	**0.58140**	**32.56**	**32.58**	**30.36**	**19.61**	**30.15**	**32.60**	**31.35**	**29.71**	**29.71**	**25.96**	**29.97**	**29.96**	**32.77**	**36.95**	**41.48**	**41.59**	**41.78**
Phenolic 'NoBake	0.05850	3.28	3.28	3.05	1.97	3.03	3.28	3.15	2.99	2.99	2.61	3.02	3.02	3.30	3.72	4.17	4.19	4.20
Phenolic 'Urethane	0.23424	13.12	13.13	12.23	7.90	12.15	13.14	12.63	11.97	11.97	10.46	12.07	12.07	13.20	14.89	16.71	16.76	16.83
Phenolic ' HotBox	0.23424	13.12	13.13	12.23	7.90	12.15	13.14	12.63	11.97	11.97	10.46	12.07	12.07	13.20	14.89	16.71	16.76	16.83
Green 'Sand	0.00786	0.44	0.44	0.41	0.27	0.41	0.44	0.42	0.40	0.40	0.35	0.41	0.41	0.44	0.50	0.56	0.56	0.56
Core Oil	0.00342	0.19	0.19	0.18	0.12	0.18	0.19	0.18	0.17	0.17	0.15	0.18	0.18	0.19	0.22	0.24	0.24	0.25
Shell	0.14736	8.25	8.26	7.69	4.97	7.64	8.26	7.95	7.53	7.53	6.58	7.60	7.59	8.31	9.37	10.51	10.54	10.59
Nitrogen Furan	0.00144	0.08	0.08	0.08	0.05	0.07	0.08	0.08	0.07	0.07	0.06	0.07	0.07	0.08	0.09	0.10	0.10	0.10
Nitrogen 'Furan-TSA	0.00606	0.34	0.34	0.32	0.20	0.31	0.34	0.33	0.31	0.31	0.27	0.31	0.31	0.34	0.39	0.43	0.43	0.44
Furan ' HotBox	0.00096	0.05	0.05	0.05	0.03	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.05	0.06	0.07	0.07	0.07
Alkyd 'Isocyanate	0.00011	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silicate-'-Ester	0.01638	0.92	0.92	0.86	0.55	0.85	0.92	0.88	0.84	0.84	0.73	0.84	0.84	0.92	1.04	1.17	1.17	1.18

Binders Designations	1991 Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		Adult HAP Intake by Inhalation, ug/kg-day																
Case Study Binder	1	**2E+0**	**2E+0**	**2E+0**	**1E+0**	**2E+0**	**2E+0**	**2E+0**	**2E+0**	**2E+0**	**2E+0**	**2E+0**	**2E+0**	**2E+0**	**2E+0**	**3E+0**	**3E+0**	**3E+0**
Phenolic 'NoBake	2	2E-1	2E-1	2E-1	1E-1	2E-1	2E-1	2E-1	2E-1	2E-1	2E-1	2E-1	2E-1	2E-1	2E-1	3E-1	3E-1	3E-1
Phenolic 'Urethane	3	9E-1	9E-1	8E-1	5E-1	8E-1	9E-1	8E-1	8E-1	8E-1	7E-1	8E-1	8E-1	9E-1	1E+0	1E+0	1E+0	1E+0
Phenolic ' HotBox	4	9E-1	9E-1	8E-1	5E-1	8E-1	9E-1	8E-1	8E-1	8E-1	7E-1	8E-1	8E-1	9E-1	1E+0	1E+0	1E+0	1E+0
Green 'Sand	5	3E-2	3E-2	3E-2	2E-2	3E-2	3E-2	3E-2	3E-2	3E-2	2E-2	3E-2	3E-2	3E-2	3E-2	4E-2	4E-2	4E-2
Core Oil	6	1E-2	1E-2	1E-2	8E-3	1E-2	1E-2	1E-2	1E-2	1E-2	1E-2	1E-2	1E-2	1E-2	1E-2	2E-2	2E-2	2E-2
Shell	7	6E-1	6E-1	5E-1	3E-1	5E-1	6E-1	5E-1	5E-1	5E-1	4E-1	5E-1	5E-1	6E-1	6E-1	7E-1	7E-1	7E-1
Nitrogen Furan	8	5E-3	5E-3	5E-3	3E-3	5E-3	5E-3	5E-3	5E-3	5E-3	4E-3	5E-3	5E-3	5E-3	6E-3	7E-3	7E-3	7E-3
Nitrogen 'Furan-TSA	9	2E-2	2E-2	2E-2	1E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	3E-2	3E-2	3E-2	3E-2
Furan ' HotBox	10	4E-3	4E-3	3E-3	2E-3	3E-3	4E-3	3E-3	3E-3	3E-3	3E-3	3E-3	3E-3	4E-3	4E-3	5E-3	5E-3	5E-3
Alkyd 'Isocyanate	11	4E-4	4E-4	4E-4	2E-4	4E-4	4E-4	4E-4	4E-4	4E-4	3E-4	4E-4	4E-4	4E-4	5E-4	5E-4	5E-4	5E-4
Silicate-'-Ester	12	6E-2	6E-2	6E-2	4E-2	6E-2	6E-2	6E-2	6E-2	6E-2	5E-2	6E-2	6E-2	6E-2	7E-2	8E-2	8E-2	8E-2

RisMode The @RISK Model
Human Health Risk Analysis

Intake = (CA)x(IR)x(ET)x(EF)x(ED) / (BW)x(AT)

Toluene Concentrations and Intakes from Commercial Binders at Receptor R3

Binders Designations	1991 EMF Lb/t iron	HAP Concentration in Air C_{air}, ug/m3 7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Case Study Binder	**0.03400**	**1.90**	**1.91**	**1.78**	**1.15**	**1.76**	**1.91**	**1.83**	**1.74**	**1.74**	**1.52**	**1.75**	**1.75**	**1.92**	**2.16**	**2.43**	**2.43**	**2.44**
Phenolic 'NoBake	0.03804	2.13	2.13	1.99	1.28	1.97	2.13	2.05	1.94	1.94	1.70	1.96	1.96	2.14	2.42	2.71	2.72	2.73
Phenolic 'Urethane	0.04998	2.80	2.80	2.61	1.69	2.59	2.80	2.70	2.55	2.55	2.23	2.58	2.58	2.82	3.18	3.57	3.58	3.59
Phenolic ' HotBox	0.01092	0.61	0.61	0.57	0.37	0.57	0.61	0.59	0.56	0.56	0.49	0.56	0.56	0.62	0.69	0.78	0.78	0.78
Green 'Sand	0.00378	0.21	0.21	0.20	0.13	0.20	0.21	0.20	0.19	0.19	0.17	0.19	0.19	0.21	0.24	0.27	0.27	0.27
Core Oil	0.02868	1.61	1.61	1.50	0.97	1.49	1.61	1.55	1.47	1.47	1.28	1.48	1.48	1.62	1.82	2.05	2.05	2.06
Shell	0.16842	9.43	9.44	8.79	5.68	8.73	9.44	9.08	8.61	8.61	7.52	8.68	8.68	9.49	10.71	12.02	12.05	12.10
Nitrogen Furan	0.00726	0.41	0.41	0.38	0.24	0.38	0.41	0.39	0.37	0.37	0.32	0.37	0.37	0.41	0.46	0.52	0.52	0.52
Nitrogen 'Furan-TSA	0.52956	29.66	29.67	27.65	17.86	27.46	29.70	28.56	27.06	27.06	23.64	27.30	27.29	29.85	33.66	37.78	37.88	38.06
Furan ' HotBox	0.00192	0.11	0.11	0.10	0.06	0.10	0.11	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.12	0.14	0.14	0.14
Alkyd 'Isocyanate	0.00154	0.09	0.09	0.08	0.05	0.08	0.09	0.08	0.08	0.08	0.07	0.08	0.08	0.09	0.10	0.11	0.11	0.11
Silicate-'-Ester	0.01692	0.95	0.95	0.88	0.57	0.88	0.95	0.91	0.86	0.86	0.76	0.87	0.87	0.95	1.08	1.21	1.21	1.22

Binders Designations	1991 Period	Adult HAP Intake by Inhalation, ug/kg-day 7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Case Study Binder	**1**	**0.13**	**0.13**	**0.12**	**0.08**	**0.12**	**0.13**	**0.12**	**0.12**	**0.12**	**0.10**	**0.12**	**0.12**	**0.13**	**0.15**	**0.16**	**0.16**	**0.16**
Phenolic 'NoBake	2	0.14	0.14	0.13	0.09	0.13	0.14	0.14	0.13	0.13	0.11	0.13	0.13	0.14	0.16	0.18	0.18	0.18
Phenolic 'Urethane	3	0.19	0.19	0.18	0.11	0.17	0.19	0.18	0.17	0.17	0.15	0.17	0.17	0.19	0.21	0.24	0.24	0.24
Phenolic ' HotBox	4	0.04	0.04	0.04	0.02	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.05
Green 'Sand	5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
Core Oil	6	0.11	0.11	0.10	0.06	0.10	0.11	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.12	0.14	0.14	0.14
Shell	7	0.63	0.63	0.59	0.38	0.59	0.63	0.61	0.58	0.58	0.51	0.58	0.58	0.64	0.72	0.81	0.81	0.81
Nitrogen Furan	8	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.04
Nitrogen 'Furan-TSA	9	1.99	1.99	1.86	1.20	1.84	1.99	1.92	1.82	1.82	1.59	1.83	1.83	2.01	2.26	2.54	2.54	2.56
Furan ' HotBox	10	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Alkyd 'Isocyanate	11	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silicate-'-Ester	12	0.06	0.06	0.06	0.04	0.06	0.06	0.06	0.06	0.06	0.05	0.06	0.06	0.06	0.07	0.08	0.08	0.08

RisMode The @RISK Model
Human Health Risk Analysis

Intake = (CA)x(IR)x(ET)x(EF)x(ED) / (BW)x(AT)

Xylene Concentrations and Intakes from Commercial Binders at Receptor R3

Binders Designations	1991 EMF Lb/t iron	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		HAP Concentration in Air C_{air}, ug/m^3																
Case Study Binder	0.02080	**1.17**	**1.17**	**1.09**	**0.70**	**1.08**	**1.17**	**1.12**	**1.06**	**1.06**	**0.93**	**1.07**	**1.07**	**1.17**	**1.32**	**1.48**	**1.49**	**1.49**
Phenolic 'NoBake	0.00582	0.33	0.33	0.30	0.20	0.30	0.33	0.31	0.30	0.30	0.26	0.30	0.30	0.33	0.37	0.42	0.42	0.42
Phenolic Urethane	0.02634	1.48	1.48	1.38	0.89	1.37	1.48	1.42	1.35	1.35	1.18	1.36	1.36	1.48	1.67	1.88	1.88	1.89
Phenolic ' HotBox	0.00726	0.41	0.41	0.38	0.24	0.38	0.41	0.39	0.37	0.37	0.32	0.37	0.37	0.41	0.46	0.52	0.52	0.52
Green Sand	0.00126	0.07	0.07	0.07	0.04	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.07	0.08	0.09	0.09	0.09
Core Oil	0.01434	0.80	0.80	0.75	0.48	0.74	0.80	0.77	0.73	0.73	0.64	0.74	0.74	0.81	0.91	1.02	1.03	1.03
Shell	0.03510	1.97	1.97	1.83	1.18	1.82	1.97	1.89	1.79	1.79	1.57	1.81	1.81	1.98	2.23	2.50	2.51	2.52
Nitrogen Furan	0.13362	7.48	7.49	6.98	4.51	6.93	7.49	7.21	6.83	6.83	5.97	6.89	6.89	7.53	8.49	9.53	9.56	9.60
Nitrogen Furan-TSA	0.01458	0.82	0.82	0.76	0.49	0.76	0.82	0.79	0.74	0.75	0.65	0.75	0.75	0.82	0.93	1.04	1.04	1.05
Furan ' HotBox	0.00192	0.11	0.11	0.10	0.06	0.10	0.11	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.12	0.14	0.14	0.14
Alkyd 'Isocyanate	0.15132	8.48	8.48	7.90	5.10	7.85	8.49	8.16	7.73	7.73	6.76	7.80	7.80	8.53	9.62	####	10.83	10.87
Silicate-'-Ester	0.00564	0.32	0.32	0.29	0.19	0.29	0.32	0.30	0.29	0.29	0.25	0.29	0.29	0.32	0.36	0.40	0.40	0.41

Binders Designations	1991 Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		Adult HAP Intake by Inhalation, ug/kg-day																
Case Study Binder	1	**8E-2**	**8E-2**	**7E-2**	**5E-2**	**7E-2**	**8E-2**	**8E-2**	**7E-2**	**7E-2**	**6E-2**	**7E-2**	**7E-2**	**8E-2**	**9E-2**	**1E-1**	**1E-1**	**1E-1**
Phenolic 'NoBake	2	2E-2	2E-2	2E-2	1E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	3E-2	3E-2	3E-2
[illegible]	3	1E-1	1E-1	9E-2	6E-2	9E-2	1E-1	1E-1	9E-2	9E-2	8E-2	9E-2	9E-2	1E-1	1E-1	1E-1	1E-1	1E-1
Phenolic ' HotBox	4	3E-2	3E-2	3E-2	2E-2	3E-2	3E-2	3E-2	2E-2	2E-2	2E-2	3E-2	3E-2	3E-2	3E-2	3E-2	3E-2	4E-2
[illegible]	5	5E-3	5E-3	4E-3	3E-3	4E-3	5E-3	5E-3	4E-3	4E-3	4E-3	4E-3	4E-3	5E-3	5E-3	6E-3	6E-3	6E-3
Core Oil	6	5E-2	5E-2	5E-2	3E-2	5E-2	5E-2	5E-2	5E-2	5E-2	4E-2	5E-2	5E-2	5E-2	6E-2	7E-2	7E-2	7E-2
[illegible]	7	1E-1	1E-1	1E-1	8E-2	1E-1	1E-1	1E-1	1E-1	1E-1	1E-1	1E-1	1E-1	1E-1	1E-1	2E-1	2E-1	2E-1
Nitrogen Furan	8	5E-1	5E-1	5E-1	3E-1	5E-1	5E-1	5E-1	5E-1	5E-1	4E-1	5E-1	5E-1	5E-1	6E-1	6E-1	6E-1	6E-1
[illegible]	9	5E-2	5E-2	5E-2	3E-2	5E-2	5E-2	5E-2	5E-2	5E-2	4E-2	5E-2	5E-2	6E-2	6E-2	7E-2	7E-2	7E-2
Furan ' HotBox	10	7E-3	7E-3	7E-3	4E-3	7E-3	7E-3	7E-3	7E-3	7E-3	6E-3	7E-3	7E-3	7E-3	8E-3	9E-3	9E-3	9E-3
[illegible]	11	6E-1	6E-1	5E-1	3E-1	5E-1	6E-1	5E-1	5E-1	5E-1	5E-1	5E-1	5E-1	6E-1	6E-1	7E-1	7E-1	7E-1
Silicate-'-Ester	12	2E-2	2E-2	2E-2	1E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	3E-2	3E-2	3E-2

APPENDIX J

Risk and Hazard Index Calculation

RisMode The @RISK Model :
Human Health Risk Analysis
1987-1991

Risk = Intake x Slope Factor

Benzene Risk Values at Receptor R1

Conc. in Air C_{air}, ug/m³	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
	1987	3.14	3.14	3.13	1.96	3.25	3.07	3.07	3.07	3.69	3.08	3.07	3.07	3.07	3.07	3.07	3.03	3.03
	1988	3.48	3.79	3.79	3.33	3.74	3.74	3.20	2.55	2.54	2.35	2.13	2.24	2.88	3.01	3.20	3.38	3.94
	1989	4.59	4.59	4.59	3.45	3.45	2.29	2.25	2.23	2.39	2.39	2.39	2.41	2.55	2.69	2.69	2.90	3.65
	1990	4.54	4.54	4.53	4.38	4.36	4.00	3.80	3.80	2.50	2.46	1.82	1.88	1.86	2.28	2.28	2.30	2.98
	1991	3.16	3.00	2.68	1.87	3.05	3.05	3.39	2.80	2.82	2.43	2.69	2.66	2.65	3.09	3.16	3.27	3.27
Risk Values from Inhalation of Benzene	**Period**	**7AM**	**8AM**	**9AM**	**10AM**	**11AM**	**12PM**	**1PM**	**2PM**	**3PM**	**4PM**	**5PM**	**6PM**	**7PM**	**8PM**	**9PM**	**10PM**	**11PM**
	1987	6E-6	6E-6	6E-6	4E-6	6E-6	6E-6	6E-6	6E-6	7E-6	6E-6	6E-6	6E-6	6E-6	6E-6	6E-6	6E-6	6E-6
	1988	7E-6	7E-6	7E-6	6E-6	7E-6	7E-6	6E-6	5E-6	5E-6	5E-6	4E-6	4E-6	6E-6	6E-6	6E-6	7E-6	8E-6
Child	1989	9E-6	9E-6	9E-6	7E-6	7E-6	4E-6	4E-6	4E-6	5E-6	5E-6	5E-6	5E-6	5E-6	5E-6	5E-6	6E-6	7E-6
	1990	9E-6	9E-6	9E-6	9E-6	9E-6	8E-6	7E-6	7E-6	5E-6	5E-6	4E-6	4E-6	4E-6	4E-6	4E-6	4E-6	6E-6
	1991	6E-6	6E-6	5E-6	4E-6	6E-6	6E-6	7E-6	5E-6	6E-6	5E-6	5E-6	5E-6	5E-6	6E-6	6E-6	6E-6	6E-6
	Period	**7AM**	**8AM**	**9AM**	**10AM**	**11AM**	**12PM**	**1PM**	**2PM**	**3PM**	**4PM**	**5PM**	**6PM**	**7PM**	**8PM**	**9PM**	**10PM**	**11PM**
	1987	6E-5	6E-5	6E-5	4E-5	6E-5	6E-5	6E-5	6E-5	7E-5	6E-5	6E-5	6E-5	6E-5	6E-5	6E-5	6E-5	6E-5
	1988	7E-5	7E-5	7E-5	6E-5	7E-5	7E-5	6E-5	5E-5	5E-5	4E-5	4E-5	4E-5	5E-5	6E-5	6E-5	6E-5	7E-5
Women	1989	9E-5	9E-5	9E-5	6E-5	6E-5	4E-5	4E-5	4E-5	4E-5	4E-5	4E-5	5E-5	5E-5	5E-5	5E-5	5E-5	7E-5
	1990	9E-5	9E-5	9E-5	8E-5	8E-5	8E-5	7E-5	7E-5	5E-5	5E-5	3E-5	4E-5	3E-5	4E-5	4E-5	4E-5	6E-5
	1991	6E-5	6E-5	5E-5	4E-5	6E-5	6E-5	6E-5	5E-5	5E-5	5E-5	5E-5	5E-5	5E-5	6E-5	6E-5	6E-5	6E-5
	Period	**7AM**	**8AM**	**9AM**	**10AM**	**11AM**	**12PM**	**1PM**	**2PM**	**3PM**	**4PM**	**5PM**	**6PM**	**7PM**	**8PM**	**9PM**	**10PM**	**11PM**
	1987	5E-5	5E-5	5E-5	3E-5	5E-5	5E-5	5E-5	5E-5	6E-5	5E-5	5E-5	5E-5	5E-5	5E-5	5E-5	5E-5	5E-5
	1988	5E-5	6E-5	6E-5	5E-5	6E-5	6E-5	5E-5	4E-5	4E-5	4E-5	3E-5	3E-5	4E-5	5E-5	5E-5	5E-5	6E-5
Men	1989	7E-5	7E-5	7E-5	5E-5	5E-5	4E-5	4E-5	3E-5	4E-5	4E-5	4E-5	4E-5	4E-5	4E-5	4E-5	5E-5	6E-5
	1990	7E-5	7E-5	7E-5	7E-5	7E-5	6E-5	6E-5	6E-5	4E-5	4E-5	3E-5	3E-5	3E-5	4E-5	4E-5	4E-5	5E-5
	1991	5E-5	5E-5	4E-5	3E-5	5E-5	5E-5	5E-5	4E-5	4E-5	4E-5	4E-5	4E-5	4E-5	5E-5	5E-5	5E-5	5E-5

RisMode The @RISK Model
Human Health Risk Analysis
1987-1991

Risk = Intake x Slope Factor

Benzene Risk Values at Receptor R2

	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Conc. in Air C_{air}, ug/m^3		=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
	1987	4.47	4.47	4.48	2.51	3.86	4.33	4.65	4.98	4.98	5.05	4.56	4.63	4.61	4.22	4.24	4.21	4.86
	1988	6.14	5.55	5.22	3.89	5.54	5.04	5.02	4.90	4.80	4.42	4.02	3.81	4.03	4.08	4.38	4.48	4.55
	1989	5.10	5.10	4.93	4.38	4.05	4.05	4.52	4.31	4.34	3.85	3.69	4.26	4.05	3.81	3.96	3.69	3.86
	1990	5.03	5.03	5.03	5.03	5.03	4.77	4.68	4.68	4.68	4.16	3.74	3.62	4.14	4.86	5.40	5.84	5.97
	1991	4.92	5.06	4.38	2.83	4.22	3.88	3.76	3.91	4.39	4.44	4.57	4.57	4.50	4.16	3.88	3.87	3.87
Risk Values from Inhalation of Benzene	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
	1987	1E-5	1E-5	1E-5	6E-6	9E-6	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5
	1988	1E-5	1E-5	1E-5	9E-6	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	9E-6	9E-6	9E-6	9E-6	1E-5	1E-5	1E-5
Child	1989	1E-5	1E-5	1E-5	1E-5	9E-6	9E-6	1E-5	1E-5	1E-5	9E-6	9E-6	1E-5	9E-6	9E-6	9E-6	9E-6	9E-6
	1990	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	9E-6	8E-6	1E-5	1E-5	1E-5	1E-5	1E-5
	1991	1E-5	1E-5	1E-5	7E-6	1E-5	9E-6	9E-6	9E-6	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	9E-6	9E-6	9E-6
	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
	1987	8E-5	8E-5	8E-5	5E-5	7E-5	8E-5	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5	8E-5	8E-5	8E-5	9E-5
	1988	1E-4	1E-4	1E-4	7E-5	1E-4	9E-5	9E-5	9E-5	9E-5	8E-5	8E-5	7E-5	8E-5	8E-5	8E-5	8E-5	9E-5
Women	1989	1E-4	1E-4	9E-5	8E-5	8E-5	8E-5	8E-5	8E-5	8E-5	7E-5	7E-5	8E-5	8E-5	7E-5	7E-5	7E-5	7E-5
	1990	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5	8E-5	7E-5	7E-5	8E-5	9E-5	1E-4	1E-4	1E-4
	1991	9E-5	9E-5	8E-5	5E-5	8E-5	7E-5	7E-5	7E-5	8E-5	8E-5	9E-5	9E-5	8E-5	8E-5	7E-5	7E-5	7E-5
	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
	1987	7E-5	7E-5	7E-5	4E-5	6E-5	7E-5	7E-5	8E-5	8E-5	8E-5	7E-5	7E-5	7E-5	7E-5	7E-5	7E-5	8E-5
	1988	1E-4	9E-5	8E-5	6E-5	9E-5	8E-5	8E-5	8E-5	7E-5	7E-5	6E-5	6E-5	6E-5	6E-5	7E-5	7E-5	7E-5
Men	1989	8E-5	8E-5	8E-5	7E-5	6E-5	6E-5	7E-5	7E-5	7E-5	6E-5	6E-5	7E-5	6E-5	6E-5	6E-5	6E-5	6E-5
	1990	8E-5	8E-5	8E-5	8E-5	8E-5	7E-5	7E-5	7E-5	7E-5	6E-5	6E-5	6E-5	6E-5	8E-5	8E-5	9E-5	9E-5
	1991	8E-5	8E-5	7E-5	4E-5	7E-5	6E-5	6E-5	6E-5	7E-5	7E-5	7E-5	7E-5	7E-5	6E-5	6E-5	6E-5	6E-5

RisMode The @RISK Model
Human Health Risk Analysis
1987-1991

Risk = Intake x Slope Factor

Benzene Risk Values at Receptor R3

	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Conc. in Air C_{air}, ug/m^3		====	====	====	=====	=====	=====	====	====	====	====	====	====	====	====	====	=====	====
	1987	4.47	4.62	4.48	3.05	4.40	4.02	4.02	4.05	4.78	4.78	4.78	4.78	4.78	4.81	4.81	4.90	4.90
	1988	4.50	4.57	4.56	5.04	4.63	4.75	4.97	4.97	4.53	4.33	4.38	4.64	4.61	4.50	4.76	4.86	4.77
	1989	6.47	6.54	5.55	5.11	5.11	5.11	4.42	4.39	4.16	3.41	3.25	3.70	3.81	4.49	4.49	5.32	5.32
	1990	3.91	3.48	3.48	3.47	3.49	3.09	3.07	3.07	3.17	3.03	3.02	3.18	3.50	3.54	4.01	4.39	4.42
	1991	4.71	4.71	4.39	2.84	4.36	4.72	4.54	4.30	4.30	3.75	4.33	4.33	4.74	5.35	6.00	6.02	6.04
Risk Values from Inhalation of Benzene	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		====	====	====	=====	=====	=====	====	====	====	====	====	====	====	====	====	=====	====
	1987	9E-6	9E-6	9E-6	6E-6	9E-6	8E-6	8E-6	8E-6	9E-6	9E-6	9E-6	9E-6	9E-6	9E-6	9E-6	1E-5	1E-5
	1988	9E-6	9E-6	9E-6	1E-5	9E-6	9E-6	1E-5	1E-5	9E-6	8E-6	9E-6	9E-6	9E-6	9E-6	9E-6	9E-6	9E-6
Child	1989	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	9E-6	9E-6	8E-6	7E-6	6E-6	7E-6	7E-6	9E-6	9E-6	1E-5	1E-5
	1990	8E-6	7E-6	7E-6	7E-6	7E-6	6E-6	6E-6	6E-6	6E-6	6E-6	6E-6	6E-6	7E-6	7E-6	8E-6	9E-6	9E-6
	1991	9E-6	9E-6	9E-6	6E-6	9E-6	9E-6	9E-6	8E-6	8E-6	7E-6	8E-6	8E-6	9E-6	1E-5	1E-5	1E-5	1E-5
	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		====	====	====	=====	=====	=====	====	====	====	====	====	====	====	====	====	=====	====
	1987	8E-5	9E-5	8E-5	6E-5	8E-5	8E-5	8E-5	8E-5	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5
	1988	8E-5	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5	9E-5	8E-5	8E-5	8E-5	9E-5	9E-5	8E-5	9E-5	9E-5	9E-5
Women	1989	1E-4	1E-4	1E-4	1E-4	1E-4	1E-4	8E-5	8E-5	8E-5	6E-5	6E-5	7E-5	7E-5	8E-5	8E-5	1E-4	1E-4
	1990	7E-5	7E-5	7E-5	7E-5	7E-5	6E-5	6E-5	6E-5	6E-5	6E-5	6E-5	6E-5	7E-5	7E-5	8E-5	8E-5	8E-5
	1991	9E-5	9E-5	8E-5	5E-5	8E-5	9E-5	9E-5	8E-5	8E-5	7E-5	8E-5	8E-5	9E-5	1E-4	1E-4	1E-4	1E-4
	Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		====	====	====	=====	=====	=====	====	====	====	====	====	====	====	====	====	=====	====
	1987	7E-5	7E-5	7E-5	5E-5	7E-5	6E-5	6E-5	6E-5	7E-5	7E-5	7E-5	7E-5	7E-5	8E-5	8E-5	8E-5	8E-5
	1988	7E-5	7E-5	7E-5	8E-5	7E-5	7E-5	8E-5	8E-5	7E-5	7E-5	7E-5	7E-5	7E-5	7E-5	7E-5	8E-5	7E-5
Men	1989	1E-4	1E-4	9E-5	8E-5	8E-5	8E-5	7E-5	7E-5	6E-5	5E-5	5E-5	6E-5	6E-5	7E-5	7E-5	8E-5	8E-5
	1990	6E-5	5E-5	5E-5	5E-5	5E-5	5E-5	5E-5	5E-5	5E-5	5E-5	5E-5	5E-5	5E-5	6E-5	6E-5	7E-5	7E-5
	1991	7E-5	7E-5	7E-5	4E-5	7E-5	7E-5	7E-5	7E-5	7E-5	6E-5	7E-5	7E-5	7E-5	8E-5	9E-5	9E-5	9E-5

RisMode The @RISK Model
Human Health Risk Analysis
1991

Risk = Intake x Slope Factor

Benzene Concentrations and Risk from Commercial Binders at Receptor R3

Binders Designations	1991 EMF Lb/ton iron	HAP Concentration in Air C_{air}, ug/m^3 7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Case Study Binder	**0.08410**	**4.71**	**4.71**	**4.39**	**2.84**	**4.36**	**4.72**	**4.54**	**4.30**	**4.30**	**3.75**	**4.33**	**4.33**	**4.74**	**5.35**	**6.00**	**6.02**	**6.04**
Phenolic 'NoBake	0.67254	37.67	37.69	35.11	22.69	34.88	37.71	36.27	34.36	34.37	30.03	34.66	34.66	37.91	42.75	47.98	48.11	48.33
Phenolic 'Urethane	0.32106	17.98	17.99	16.76	10.83	16.65	18.00	17.31	16.40	16.41	14.33	16.55	16.55	18.10	20.41	22.91	22.97	23.07
Phenolic ' HotBox	0.06012	3.37	3.37	3.14	2.03	3.12	3.37	3.24	3.07	3.07	2.68	3.10	3.10	3.39	3.82	4.29	4.30	4.32
Green 'Sand	0.03666	2.05	2.05	1.91	1.24	1.90	2.06	1.98	1.87	1.87	1.64	1.89	1.89	2.07	2.33	2.62	2.62	2.63
Core Oil	0.14064	7.88	7.88	7.34	4.74	7.29	7.89	7.58	7.19	7.19	6.28	7.25	7.25	7.93	8.94	10.03	10.06	10.11
Shell	0.40002	22.40	22.42	20.89	13.49	20.74	22.43	21.57	20.44	20.44	17.86	20.62	20.62	22.55	25.43	28.54	28.62	28.75
Nitrogen Furan	0.03888	2.18	2.18	2.03	1.31	2.02	2.18	2.10	1.99	1.99	1.74	2.00	2.00	2.19	2.47	2.77	2.78	2.79
Nitrogen 'Furan-TSA	0.27204	15.24	15.24	14.20	9.18	14.11	15.25	14.67	13.90	13.90	12.15	14.02	14.02	15.33	17.29	19.41	19.46	19.55
Furan ' HotBox	0.03222	1.80	1.81	1.68	1.09	1.67	1.81	1.74	1.65	1.65	1.44	1.66	1.66	1.82	2.05	2.30	2.30	2.32
Alkyd 'Isocyanate	0.32016	17.93	17.94	16.72	10.80	16.60	17.95	17.26	16.36	16.36	14.29	16.50	16.50	18.05	20.35	22.84	22.90	23.01
Silicate-'-Ester	0.08460	4.74	4.74	4.42	2.85	4.39	4.74	4.56	4.32	4.32	3.78	4.36	4.36	4.77	5.38	6.04	6.05	6.08

Binders Designations	1991 Period	Adult Risk from HAP Inhalation 7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Case Study Binder	**1**	**9E-6**	**9E-6**	**9E-6**	**6E-6**	**9E-6**	**9E-6**	**9E-6**	**8E-6**	**8E-6**	**7E-6**	**8E-6**	**8E-6**	**9E-6**	**1E-5**	**1E-5**	**1E-5**	**1E-5**
Phenolic 'NoBake	2	7E-5	7E-5	7E-5	4E-5	7E-5	7E-5	7E-5	7E-5	7E-5	6E-5	7E-5	7E-5	7E-5	8E-5	9E-5	9E-5	9E-5
Phenolic 'Urethane	3	4E-5	4E-5	3E-5	2E-5	3E-5	4E-5	3E-5	3E-5	3E-5	3E-5	3E-5	3E-5	4E-5	4E-5	4E-5	4E-5	5E-5
Phenolic ' HotBox	4	7E-6	7E-6	6E-6	4E-6	6E-6	7E-6	6E-6	6E-6	6E-6	5E-6	6E-6	6E-6	7E-6	7E-6	8E-6	8E-6	8E-6
Green 'Sand	5	4E-6	4E-6	4E-6	2E-6	4E-6	4E-6	4E-6	4E-6	4E-6	3E-6	4E-6	4E-6	4E-6	5E-6	5E-6	5E-6	5E-6
Core Oil	6	2E-5	2E-5	1E-5	9E-6	1E-5	2E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	2E-5	2E-5	2E-5	2E-5	2E-5
Shell	7	4E-5	4E-5	4E-5	3E-5	4E-5	4E-5	4E-5	4E-5	4E-5	3E-5	4E-5	4E-5	4E-5	5E-5	6E-5	6E-5	6E-5
Nitrogen Furan	8	4E-6	4E-6	4E-6	3E-6	4E-6	4E-6	4E-6	4E-6	4E-6	3E-6	4E-6	4E-6	4E-6	5E-6	5E-6	5E-6	5E-6
Nitrogen 'Furan-TSA	9	3E-5	3E-5	3E-5	2E-5	3E-5	3E-5	3E-5	3E-5	3E-5	2E-5	3E-5	3E-5	3E-5	3E-5	4E-5	4E-5	4E-5
Furan ' HotBox	10	4E-6	4E-6	3E-6	2E-6	3E-6	4E-6	3E-6	3E-6	3E-6	3E-6	3E-6	3E-6	4E-6	4E-6	4E-6	4E-6	5E-6
Alkyd 'Isocyanate	11	3E-5	4E-5	3E-5	2E-5	3E-5	4E-5	3E-5	3E-5	3E-5	3E-5	3E-5	3E-5	4E-5	4E-5	4E-5	4E-5	4E-5
Silicate-'-Ester	12	9E-6	9E-6	9E-6	6E-6	9E-6	9E-6	9E-6	8E-6	8E-6	7E-6	9E-6	9E-6	9E-6	1E-5	1E-5	1E-5	1E-5

RisMode The @RISK Model :
Human Health Risk Analysis
1991

Risk = Intake x Slope Factor

Formaldehyde Concentrations and Risk from Commercial Binders at Receptor R3

Binders Designations	1991 EMF Lb/t iron	HAP Concentration in Air C_{air}, ug/m^3 7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Case Study Binder	**0.11160**	**6.25**	**6.25**	**5.83**	**3.76**	**5.79**	**6.26**	**6.02**	**5.70**	**5.70**	**4.98**	**5.75**	**5.75**	**6.29**	**7.09**	**7.96**	**7.98**	**8.02**
Phenolic 'NoBake	0.00060	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04
Phenolic 'Urethane	0.00132	0.07	0.07	0.07	0.04	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.08	0.09	0.09	0.09
Phenolic ' HotBox	0.00036	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Green 'Sand	0.00024	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
Core Oil	0.00576	0.32	0.32	0.30	0.19	0.30	0.32	0.31	0.29	0.29	0.26	0.30	0.30	0.32	0.37	0.41	0.41	0.41
Shell	0.00210	0.12	0.12	0.11	0.07	0.11	0.12	0.11	0.11	0.11	0.09	0.11	0.11	0.12	0.13	0.15	0.15	0.15
Nitrogen Furan	0.01602	0.90	0.90	0.84	0.54	0.83	0.90	0.86	0.82	0.82	0.72	0.83	0.83	0.90	1.02	1.14	1.15	1.15
Nitrogen 'Furan-TSA	0.00390	0.22	0.22	0.20	0.13	0.20	0.22	0.21	0.20	0.20	0.17	0.20	0.20	0.22	0.25	0.28	0.28	0.28
Furan ' HotBox	0.00054	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04
Alkyd 'Isocyanate	0.00636	0.36	0.36	0.33	0.21	0.33	0.36	0.34	0.32	0.33	0.28	0.33	0.33	0.36	0.40	0.45	0.45	0.46
Silicate-'-Ester	0.01014	0.57	0.57	0.53	0.34	0.53	0.57	0.55	0.52	0.52	0.45	0.52	0.52	0.57	0.64	0.72	0.73	0.73

Binders Designations	1991 Period Year 1991	Adult Risk from HAP Inhalation 7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
Case Study Binder	**1**	**1E-5**	**1E-5**	**1E-5**	**7E-6**	**1E-5**	**1E-5**	**1E-5**	**1E-5**	**1E-5**	**1E-5**	**1E-5**	**1E-5**	**1E-5**	**1E-5**	**2E-5**	**2E-5**	**2E-5**
Phenolic 'NoBake	2	7E-8	7E-8	6E-8	4E-8	6E-8	7E-8	6E-8	6E-8	6E-8	5E-8	6E-8	6E-8	7E-8	7E-8	8E-8	8E-8	8E-8
Phenolic 'Urethane	3	1E-7	1E-7	1E-7	9E-8	1E-7	1E-7	1E-7	1E-7	1E-7	1E-7	1E-7	1E-7	1E-7	2E-7	2E-7	2E-7	2E-7
Phenolic ' HotBox	4	4E-8	4E-8	4E-8	2E-8	4E-8	4E-8	4E-8	4E-8	4E-8	3E-8	4E-8	4E-8	4E-8	4E-8	5E-8	5E-8	5E-8
Green 'Sand	5	3E-8	3E-8	2E-8	2E-8	2E-8	3E-8	3E-8	2E-8	2E-8	2E-8	2E-8	2E-8	3E-8	3E-8	3E-8	3E-8	3E-8
Core Oil	6	6E-7	6E-7	6E-7	4E-7	6E-7	6E-7	6E-7	6E-7	6E-7	5E-7	6E-7	6E-7	6E-7	7E-7	8E-7	8E-7	8E-7
Shell	7	2E-7	2E-7	2E-7	1E-7	2E-7	2E-7	2E-7	2E-7	2E-7	2E-7	2E-7	2E-7	2E-7	3E-7	3E-7	3E-7	3E-7
Nitrogen Furan	8	2E-6	2E-6	2E-6	1E-6	2E-6	2E-6	2E-6	2E-6	2E-6	1E-6	2E-6	2E-6	2E-6	2E-6	2E-6	2E-6	2E-6
Nitrogen 'Furan-TSA	9	4E-7	4E-7	4E-7	3E-7	4E-7	4E-7	4E-7	4E-7	4E-7	3E-7	4E-7	4E-7	4E-7	5E-7	5E-7	5E-7	5E-7
Furan ' HotBox	10	6E-8	6E-8	6E-8	4E-8	5E-8	6E-8	6E-8	5E-8	5E-8	5E-8	5E-8	5E-8	6E-8	7E-8	8E-8	8E-8	8E-8
Alkyd 'Isocyanate	11	7E-7	7E-7	6E-7	4E-7	6E-7	7E-7	7E-7	6E-7	6E-7	6E-7	6E-7	6E-7	7E-7	8E-7	9E-7	9E-7	9E-7
Silicate-'-Ester	12	1E-6	1E-6	1E-6	7E-7	1E-6	1E-6	1E-6	1E-6	1E-6	9E-7	1E-6	1E-6	1E-6	1E-6	1E-6	1E-6	1E-6

RisMode The @RISK Model : Human Health Risk Analysis 1991

Hazard Index = Intake/ RfC

Phenol Concentrations and Hazard Index from Commercial Binders at Receptor R3

Binders Designations	1991 EMF Lb/t iron	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		HAP Concentration in Air C_{air}, ug/m^3																
Case Study Binder	0.08410	32.56	32.58	30.36	19.61	30.15	32.60	31.35	29.71	29.71	25.96	29.97	29.96	32.77	36.95	41.48	41.59	41.78
Phenolic 'NoBake	0.67254	3.28	3.28	3.05	1.97	3.03	3.28	3.15	2.99	2.99	2.61	3.02	3.02	3.30	3.72	4.17	4.19	4.20
Phenolic 'Urethane	0.32106	13.12	13.13	12.23	7.90	12.15	13.14	12.63	11.97	11.97	10.46	12.07	12.07	13.20	14.89	16.71	16.76	16.83
Phenolic ' HotBox	0.06012	13.12	13.13	12.23	7.90	12.15	13.14	12.63	11.97	11.97	10.46	12.07	12.07	13.20	14.89	16.71	16.76	16.83
Green 'Sand	0.03666	0.44	0.44	0.41	0.27	0.41	0.44	0.42	0.40	0.40	0.35	0.41	0.41	0.44	0.50	0.56	0.56	0.56
Core Oil	0.14064	0.19	0.19	0.18	0.12	0.18	0.19	0.18	0.17	0.17	0.15	0.18	0.18	0.19	0.22	0.24	0.24	0.25
Shell	0.40002	8.25	8.26	7.69	4.97	7.64	8.26	7.95	7.53	7.53	6.58	7.60	7.59	8.31	9.37	10.51	10.54	10.59
Nitrogen Furan	0.03888	0.08	0.08	0.08	0.05	0.07	0.08	0.08	0.07	0.07	0.06	0.07	0.07	0.08	0.09	0.10	0.10	0.10
Nitrogen 'Furan-TSA	0.27204	0.34	0.34	0.32	0.20	0.31	0.34	0.33	0.31	0.31	0.27	0.31	0.31	0.34	0.39	0.43	0.43	0.44
Furan ' HotBox	0.03222	0.05	0.05	0.05	0.03	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.05	0.06	0.07	0.07	0.07
Alkyd 'Isocyanate	0.32016	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silicate-'-Ester	0.08460	0.92	0.92	0.86	0.55	0.85	0.92	0.88	0.84	0.84	0.73	0.84	0.84	0.92	1.04	1.17	1.17	1.18

Binders Designations	1991 Period Year 1991	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		Adult HI from HAP Inhalation																
Case Study Binder	1	4E-3	4E-3	3E-3	2E-3	3E-3	4E-3	4E-3	3E-3	3E-3	3E-3	3E-3	3E-3	4E-3	4E-3	5E-3	5E-3	5E-3
Phenolic 'NoBake	2	4E-4	4E-4	3E-4	2E-4	3E-4	4E-4	4E-4	3E-4	3E-4	3E-4	3E-4	3E-4	4E-4	4E-4	5E-4	5E-4	5E-4
Phenolic 'Urethane	3	1E-3	1E-3	1E-3	9E-4	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	2E-3	2E-3	2E-3	2E-3
Phenolic ' HotBox	4	1E-3	1E-3	1E-3	9E-4	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	2E-3	2E-3	2E-3	2E-3
Green 'Sand	5	5E-5	5E-5	5E-5	3E-5	5E-5	5E-5	5E-5	4E-5	4E-5	4E-5	5E-5	5E-5	5E-5	6E-5	6E-5	6E-5	6E-5
Core Oil	6	2E-5	2E-5	2E-5	1E-5	2E-5	2E-5	2E-5	2E-5	2E-5	2E-5	2E-5	2E-5	2E-5	2E-5	3E-5	3E-5	3E-5
Shell	7	9E-4	9E-4	9E-4	6E-4	9E-4	9E-4	9E-4	8E-4	8E-4	7E-4	9E-4	9E-4	9E-4	1E-3	1E-3	1E-3	1E-3
Nitrogen Furan	8	9E-6	9E-6	8E-6	5E-6	8E-6	9E-6	9E-6	8E-6	8E-6	7E-6	8E-6	8E-6	9E-6	1E-5	1E-5	1E-5	1E-5
Nitrogen 'Furan-TSA	9	4E-5	4E-5	4E-5	2E-5	4E-5	4E-5	4E-5	3E-5	3E-5	3E-5	3E-5	3E-5	4E-5	4E-5	5E-5	5E-5	5E-5
Furan ' HotBox	10	6E-6	6E-6	6E-6	4E-6	6E-6	6E-6	6E-6	5E-6	5E-6	5E-6	6E-6	6E-6	6E-6	7E-6	8E-6	8E-6	8E-6
Alkyd 'Isocyanate	11	7E-7	7E-7	6E-7	4E-7	6E-7	7E-7	7E-7	6E-7	6E-7	5E-7	6E-7	6E-7	7E-7	8E-7	9E-7	9E-7	9E-7
Silicate-'-Ester	12	1E-4	1E-4	1E-4	6E-5	1E-4	1E-4	1E-4	9E-5	9E-5	8E-5	9E-5	9E-5	1E-4	1E-4	1E-4	1E-4	1E-4

RisMode The @RISK Model : Human Health Risk Analysis 1991

Hazard Index = Intake/ RfC

Toluene Concentrations and Hazard Index from Commercial Binders at Receptor R3

Binders Designations	1991 EMF Lb/t iron	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		HAP Concentration in Air C_{air}, ug/m^3																
Case Study Binder	**0.03400**	**1.90**	**1.91**	**1.78**	**1.15**	**1.76**	**1.91**	**1.83**	**1.74**	**1.74**	**1.52**	**1.75**	**1.75**	**1.92**	**2.16**	**2.43**	**2.43**	**2.44**
Phenolic 'NoBake	0.03804	2.13	2.13	1.99	1.28	1.97	2.13	2.05	1.94	1.94	1.70	1.96	1.96	2.14	2.42	2.71	2.72	2.73
Phenolic 'Urethane	0.04998	2.80	2.80	2.61	1.69	2.59	2.80	2.70	2.55	2.55	2.23	2.58	2.58	2.82	3.18	3.57	3.58	3.59
Phenolic ' HotBox	0.01092	0.61	0.61	0.57	0.37	0.57	0.61	0.59	0.56	0.56	0.49	0.56	0.56	0.62	0.69	0.78	0.78	0.78
Green 'Sand	0.00378	0.21	0.21	0.20	0.13	0.20	0.21	0.20	0.19	0.19	0.17	0.19	0.19	0.21	0.24	0.27	0.27	0.27
Core Oil	0.02868	1.61	1.61	1.50	0.97	1.49	1.61	1.55	1.47	1.47	1.28	1.48	1.48	1.62	1.82	2.05	2.05	2.06
Shell	0.16842	9.43	9.44	8.79	5.68	8.73	9.44	9.08	8.61	8.61	7.52	8.68	8.68	9.49	10.71	12.02	12.05	12.10
Nitrogen Furan	0.00726	0.41	0.41	0.38	0.24	0.38	0.41	0.39	0.37	0.37	0.32	0.37	0.37	0.41	0.46	0.52	0.52	0.52
Nitrogen 'Furan-TSA	0.52956	29.66	29.67	27.65	17.86	27.46	29.70	28.56	27.06	27.06	23.64	27.30	27.29	29.85	33.66	37.78	37.88	38.06
Furan ' HotBox	0.00192	0.11	0.11	0.10	0.06	0.10	0.11	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.12	0.14	0.14	0.14
Alkyd 'Isocyanate	0.00154	0.09	0.09	0.08	0.05	0.08	0.09	0.08	0.08	0.08	0.07	0.08	0.08	0.09	0.10	0.11	0.11	0.11
Silicate-'-Ester	0.01692	0.95	0.95	0.88	0.57	0.88	0.95	0.91	0.86	0.86	0.76	0.87	0.87	0.95	1.08	1.21	1.21	1.22

Binders Designations	1991 Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		Adult HI from HAP Inhalation																
Case Study Binder	**1**	**1E-3**	**1E-3**	**1E-3**	**7E-4**	**1E-3**	**1E-3**	**1E-3**	**1E-3**	**1E-3**	**9E-4**	**1E-3**	**1E-3**	**1E-3**	**1E-3**	**1E-3**	**1E-3**	**1E-3**
Phenolic 'NoBake	2	1E-3	1E-3	1E-3	8E-4	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	1E-3	2E-3	2E-3	2E-3
Phenolic 'Urethane	3	2E-3	2E-3	2E-3	1E-3	2E-3	2E-3	2E-3	2E-3	2E-3	1E-3	2E-3	2E-3	2E-3	2E-3	2E-3	2E-3	2E-3
Phenolic ' HotBox	4	4E-4	4E-4	3E-4	2E-4	3E-4	4E-4	3E-4	3E-4	3E-4	3E-4	3E-4	3E-4	4E-4	4E-4	5E-4	5E-4	5E-4
Green 'Sand	5	1E-4	1E-4	1E-4	7E-5	1E-4	1E-4	1E-4	1E-4	1E-4	1E-4	1E-4	1E-4	1E-4	1E-4	2E-4	2E-4	2E-4
Core Oil	6	9E-4	9E-4	9E-4	6E-4	9E-4	9E-4	9E-4	9E-4	9E-4	8E-4	9E-4	9E-4	1E-3	1E-3	1E-3	1E-3	1E-3
Shell	7	6E-3	6E-3	5E-3	3E-3	5E-3	6E-3	5E-3	5E-3	5E-3	4E-3	5E-3	5E-3	6E-3	6E-3	7E-3	7E-3	7E-3
Nitrogen Furan	8	2E-4	2E-4	2E-4	1E-4	2E-4	2E-4	2E-4	2E-4	2E-4	2E-4	2E-4	2E-4	2E-4	3E-4	3E-4	3E-4	3E-4
Nitrogen 'Furan-TSA	9	2E-2	2E-2	2E-2	1E-2	2E-2	2E-2	2E-2	2E-2	2E-2	1E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2	2E-2
Furan ' HotBox	10	6E-5	6E-5	6E-5	4E-5	6E-5	6E-5	6E-5	6E-5	6E-5	5E-5	6E-5	6E-5	6E-5	7E-5	8E-5	8E-5	8E-5
Alkyd 'Isocyanate	11	5E-5	5E-5	5E-5	3E-5	5E-5	5E-5	5E-5	5E-5	5E-5	4E-5	5E-5	5E-5	5E-5	6E-5	6E-5	6E-5	6E-5
Silicate-'-Ester	12	6E-4	6E-4	5E-4	3E-4	5E-4	6E-4	5E-4	5E-4	5E-4	4E-4	5E-4	5E-4	6E-4	6E-4	7E-4	7E-4	7E-4

RisMode The @RISK Model
Human Health Risk Analysis
1991

Hazard Index = Intake/ RfC

Xylene Concentrations and Hazard Index from Commercial Binders at Receptor R3

Binders Designations	1991 EMF Lb/t Iron	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		HAP Concentration in Air C_{air}, ug/m³																
Case Study Binder	**0.02080**	**1.17**	**1.17**	**1.09**	**0.70**	**1.08**	**1.17**	**1.12**	**1.06**	**1.06**	**0.93**	**1.07**	**1.07**	**1.17**	**1.32**	**1.48**	**1.49**	**1.49**
Phenolic 'NoBake	0.00582	0.33	0.33	0.30	0.20	0.30	0.33	0.31	0.30	0.30	0.26	0.30	0.30	0.33	0.37	0.42	0.42	0.42
Phenolic 'Urethane	0.02634	1.48	1.48	1.38	0.89	1.37	1.48	1.42	1.35	1.35	1.18	1.36	1.36	1.48	1.67	1.88	1.88	1.89
Phenolic ' HotBox	0.00726	0.41	0.41	0.38	0.24	0.38	0.41	0.39	0.37	0.37	0.32	0.37	0.37	0.41	0.46	0.52	0.52	0.52
Green 'Sand	0.00126	0.07	0.07	0.07	0.04	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.07	0.08	0.09	0.09	0.09
Core Oil	0.01434	0.80	0.80	0.75	0.48	0.74	0.80	0.77	0.73	0.73	0.64	0.74	0.74	0.81	0.91	1.02	1.03	1.03
Shell	0.03510	1.97	1.97	1.83	1.18	1.82	1.97	1.89	1.79	1.79	1.57	1.81	1.81	1.98	2.23	2.50	2.51	2.52
Nitrogen Furan	0.13362	7.48	7.49	6.98	4.51	6.93	7.49	7.21	6.83	6.83	5.97	6.89	6.89	7.53	8.49	9.53	9.56	9.60
Nitrogen Furan-TSA	0.01458	0.82	0.82	0.76	0.49	0.76	0.82	0.79	0.74	0.75	0.65	0.75	0.75	0.82	0.93	1.04	1.04	1.05
Furan ' HotBox	0.00192	0.11	0.11	0.10	0.06	0.10	0.11	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.12	0.14	0.14	0.14
Alkyd 'Isocyanate	0.15132	8.48	8.48	7.90	5.10	7.85	8.49	8.16	7.73	7.73	6.76	7.80	7.80	8.53	9.62	10.80	10.83	10.87
Silicate-'-Ester	0.00564	0.32	0.32	0.29	0.19	0.29	0.32	0.30	0.29	0.29	0.25	0.29	0.29	0.32	0.36	0.40	0.40	0.41

Binders Designations	1991 Period	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM
		Adult HI from HAP Inhalation																
Case Study Binder	1	**4E-5**	**4E-5**	**4E-5**	**2E-5**	**4E-5**	**4E-5**	**4E-5**	**4E-5**	**4E-5**	**3E-5**	**4E-5**	**4E-5**	**4E-5**	**4E-5**	**5E-5**	**5E-5**	**5E-5**
Phenolic 'NoBake	2	1E-5	1E-5	1E-5	7E-6	1E-5	1E-5	1E-5	1E-5	1E-5	9E-6	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5
Phenolic 'Urethane	3	5E-5	5E-5	5E-5	3E-5	5E-5	5E-5	5E-5	5E-5	5E-5	4E-5	5E-5	5E-5	5E-5	6E-5	6E-5	6E-5	6E-5
Phenolic ' HotBox	4	1E-5	1E-5	1E-5	8E-6	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	2E-5	2E-5	2E-5	2E-5
Green 'Sand	5	2E-6	2E-6	2E-6	1E-6	2E-6	2E-6	2E-6	2E-6	2E-6	2E-6	2E-6	2E-6	2E-6	3E-6	3E-6	3E-6	3E-6
Core Oil	6	3E-5	3E-5	3E-5	2E-5	2E-5	3E-5	3E-5	2E-5	2E-5	2E-5	2E-5	2E-5	3E-5	3E-5	3E-5	3E-5	3E-5
Shell	7	7E-5	7E-5	6E-5	4E-5	6E-5	7E-5	6E-5	6E-5	6E-5	5E-5	6E-5	6E-5	7E-5	7E-5	8E-5	8E-5	8E-5
Nitrogen Furan	8	3E-4	3E-4	2E-4	2E-4	2E-4	3E-4	2E-4	2E-4	2E-4	2E-4	2E-4	2E-4	3E-4	3E-4	3E-4	3E-4	3E-4
Nitrogen Furan-TSA	9	3E-5	3E-5	3E-5	2E-5	3E-5	3E-5	3E-5	3E-5	3E-5	2E-5	3E-5	3E-5	3E-5	3E-5	3E-5	4E-5	4E-5
Furan ' HotBox	10	4E-6	4E-6	3E-6	2E-6	3E-6	4E-6	3E-6	3E-6	3E-6	3E-6	3E-6	3E-6	4E-6	4E-6	5E-6	5E-6	5E-6
Alkyd 'Isocyanate	11	3E-4	3E-4	3E-4	2E-4	3E-4	3E-4	3E-4	3E-4	3E-4	2E-4	3E-4	3E-4	3E-4	3E-4	4E-4	4E-4	4E-4
Silicate-'-Ester	12	1E-5	1E-5	1E-5	6E-6	1E-5	1E-5	1E-5	1E-5	1E-5	8E-6	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5	1E-5

BIBLIOGRAPHY

Bibliography

AFS, Exhaust Systems and Hood Design. Foundry Environmental Control, 1972. 1(4): p. 1-17.

A.F.S., Foundries Face Stricter Air Quality, Pollution Monitoring. Modern Casting, 1990: p. 33-35.

AFS and C.I.S. Association, FORM R - Reporting of Binder Chemicals Used in Foundries, 1995. American Foundrymen's Association: Des Plaines, IL.

A.C.G.I.H., Industrial Ventillation - A Manual of Recommended Practice. 13 ed. American Conference of Governmental Industrial Hygienists, 1974. Ann Arbor, MI.: Edwards Brothers Incorporated.

Allaire, M., et al., Atmospheric Polycyclic Aromatic Hydrocarbons (PAH) at a Point Source of Emissions. Part B: PAH Emissions Reduction at a Horizontal Stud Soderberg Plant at Jonquier, Quebec, Canada and Evolution of B[a}P in Ambient Air. Air & Waste Management Association, 1993. 43(January): p. 85-90.

Allen, G.R., J.J. Archibald, and T. Keenan. Hazardous Air Pollutants a Challenge to the Metal Casting Industry. in 95th AFS Casting Congress, 1991. Birmingham, Alabama: American Foundrymen's Society Inc.

Alm, A.L., Ecological Economics. Environmental Science & Technology, 1990. 24(12): p. 1783-1783.

Ames, S. Gold, and Shigenaga, Cancer Prevention, Rodent High-Dose Cancer Tests, and Risk Assessment. Risk Analysis, 1996. 16(5): p. 613-617.

Anderson, B. and K. Anderson, Determination of Tertiary Amines in Air. APPLIED INDUSTRY HYGIENE, 1989. 4(7): p. 175-179.

Andjelkovitch, D.A., et al., Formaldehyde Exposure Not Associated with Cancer of the Respiratory Tract in Iron Foundry Workers. Chemical Industry Institute of Toxicology (CIIT), 1995. 15(7): p. 1-9.

Angus, H.T., Cast Iron: Physical and Engineering Properties, 1976.

Asante Duah, K.D., Hazardous Waste Risk Assessment. 1993, Boca Raton, Florida.

Association, A.F.S., Cast Metals Handbook. 4th ed., 1944. Chicago.

ATSDR, Case Studies in Environmental Medecine, 1993. U.S.Department of Health and Human Services.

ATSDR, Case Studies in Environmental Medecine, 1992. U.S.Department of Health and Human Services.

Aunan, K., Exposure-Response Funtions Functions for Health Effects of Air Pollutants Based on Epidemiological Findings. Risk Analysis, 1996. 16(5): p. 693- 709.

Baird, B.F., Managerial Decisions Under Uncertainty An Introduction to the Analysis of Decision Making. ETM, ed. W.S.i.E.T. Management. Vol. 1, 1989. Toronto, CAN: John Willey & Sons, Inc. 530.

Baltzis, B.C. and D.S. de la Cruz. Removal of Xylene Vapors in a Biotrickling Filter. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Barry, T.M., Recommendations on Testing and Use of Pseudo-Random Number Generators Use in Monte Carlo Analysis for Risk Assessment. Risk Analysis, 1996. 16(1): p. 93-105.

Bate, C.E. and W.D. Scott, Better Foundry Hygiene Through Permanent Mold Casting, 1976. Southern Research Institute Birmingham, Alabama: Birmingham, Alabama.

Bates, C.E. and L.D. Scheel, Processing Emissions and Occupational Health in the Ferrous Foundry Industry. American Industrial Hygiene Association, 1974: p. 452-462.

Bates, C.E. and W.D. Scott, The Decomposition of Resin Binders and the Relationship Between Gases Formed and the Casting Surface Quality Part 2-Gray Iron. AFS Transactions, 1975. 134: p. 793-804.

Bates, C.E., W.D. Scott, and R.H. James, Point-source Emissions from Foudry Molds, 1978. Southern Research Institute, USA.: Birmingham, Alabama.

Belglund, R., Effective Ventilation During Plating - Capture Efficiency for Rim Exhausts. MetaL Finishing, 1995. 93: p. 79-83.

Bernard, W.R., Emission factors for Iron and Steel Sources- Criteria and toxic pollutants, 1990. EPA, Research triangle Park, North Carolina: North Carolina.

Bhatte, M.J. and K. Doshi. Title V Emissions Inventory: Estmating Potential and Actual Emissions from Metal Working Sources. in 88th Annual Meeting & Exhibition, 1995. San Antonio, Texas.

Bogen, K.T. and R.C. Spear, Integrating Uncertainty and Interindividual Variability in Environmental Risk Assessment. Risk Analysis, 1987. 7(4): p. 427-436.

Bonanti, C.J. and G.P. Patridge. Predicting Acute Toxic Chemical Exposures from Accidental Chemical Releases. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Borchelt, R., New Methods for Determining Air Pollution Exposure, in NewsReport, 1991. p. 10-12.

Branch, M.R.B.a.N.A.D., AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants, 1990. U.S. EPA: Research Triangle Park, NC.

Brand, K.P. and M.J. Small, Updating Uncertainty in an integrated Risk Assessment: Conceptual Framework and Methods. Risk Analysis, 1995. 15(6): p. 719-731.

Brandmeyer-Cawifiel, J.E., Input Uncertainties for the Urban Airshed Model, 1995.

Brothers, H.S. Incorporating Pollution Prevention into MACT Standards: An Alternative Compliance Strategy. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Bukowski, J., L. Korn, and D. Wartenberg, Correlated Inputs in Quatitative Risk Assessment: The effects of Distributional Shape. Risk Assessment, 1995. 15(2): p. 215-219.

Burmaster, D.E. and P.D. Anderson, Principles of Good Practice for the Use of Monte Carlo Techniques in Human Health and Ecological Risk. Risk Analysis, 1994. 14(4): p. 477-481.

Burmaster, D.E. and R.H. Harris, The Magnitude of Compounding Conservatisms in Superfund Risk Assessments. Risk Analysis, 1993. 13(2): p. 131-134.

Burmaster, D.E. and D.A. Hull. LogNormal Probability Plots as a Way to distinguish and Visualize Variability and Uncertainty in a LogNormal Random variability. in 88th Annual Meeting 7 Exhibition, 1995. san Antonio, Texas.

Burmaster, D.E. and K. Von Stackelberg, Using Monte Carlo Simulations in Public Health Risk Assessments: Estimating and Presenting Full Distributions of Risk. Journal of Exposure Analysis and Environmental Epidemiology, 1991. 1(4): p. 491-511.

Bush, J.E. Internet Publishing an Introduction and Discussion of Basics. in 88th Annual Meeting 7 Exhibition, 1995. san Antonio, Texas.

Butler, J.P., et al., Assessment of Carcinogenic Risk from Personal Exposure to Benzo(a)pyrene in the Human Environmental Exposure Study. Air & Waste Management Association, 1993. 43: p. 970-977.

Caister, R.L. Environmental Challenge Facing the Foundry Industry. in 3rd Annual Environmental Affairs Conference, 1992: American Founfrymen's society.

Calabrese, E.J. and E.M. Kenyon, Air Toxics and Risk Assessment. Toxicology and Environmental Health, ed. E.J. Calabrese, 1991. Chelsea: Lewis Publishers, Inc. 662.

Canter, D.A. Assessment Risks from Facilities Burning Hazardous Waste: EPA Experience to Date. in 88th Annual Meeting 7 Exhibition, 1995. San Antonio, Texas.

Carey, P.R., Updating Resin Binder Processes - Part VII. FOUNDRY M&T, 1986(September 1986): p. 90-98.

Carey, P.R., Today's Resin Binder Processes for Coremaking. FOUNDRY Management & Technology, 1990: p. 32-39.

Carey, P.R., Updating Resin Binder Processes - Part VI. FOUNDRY M&T, 1986(July 1986): p. 84-88.

Carey, P.R. and T.C. Wade, Updating Resin Binder Processes - Part IV. Foundry Management and Technology, 1986(July): p. 90 - 98.

Catizone, P.A., et al. CTDMPLUS/ISC2 Model Application at a Major Smelting Facility Analysis and Results. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Chadha, N., Develiop Multimedia Pollution Prevention Strategies. Chemical Engineering Progress, 1994(November): p. 32-38.

Chadha, N. and C.S. Parmele, Minimize Emissions of Air Toxics via Process Changes. Chemical Engineering Process, 1993: p. 37-42.

Chaloux, S. Risk Communications: The Risk Management Rule (Clean Air Act). in 88th Annual Meeting & Exhibition, 1995. San Antonio, Texas.

Clemon, R.T., Making Hard Decisions an Introduction to Decision analysis, 1990. Boston: PWS-KENT Publishig Company. 557.

Cogliano, V.J., Plausible Upper Bounds: Are their Sums Plausible? Risk Analysis, 1997. 17(1): p. 77-84.

Conference, C.A. Casting Industry Clean Air/Environmental Conference. in Casting Industry Clean Air/Environmental Conference, 1994. Chicago, Illinois.

Consultants, T., Industrial Source Complex, 1996. Trinity Consultants: Dallas, TX.

Cooper, H.B. and W.J. Green, Energy Consumption Requirements for Air Pollution Control Equipment at an Iron Foundry. Control Technology News, 1978. 28(5): p. 545-548.

Copeland, T.L., et al., Use of Probabilistic Methods to understand the Conservatism in California's Approach to Assessing Health Risks Posed by Air Contaminants. Air & Waste Management Association, 1994. 44(December): p. 1399-1413.

Copeland, T.L., et al., Comparing the Results of a Monte Carlo Analyis with the EPA's Reasonable Maximum Exposed Individual (RMEI): A Case Study of a Former Wood Trestment Site. Regulatory Toxicology and Pharmacology, 1993(18): p. 275-312.

Coulter, C.T. and J.S. Touma. Proposed Revisions to EPA's Guideline on Quality Models. in 88th Annual Meeting 7 Exhibition, 1995. san Antonio, Texas.

Cronin, W.J., et al., A Trichloroethylene Risk Assessment Using Monte Carlo Analysis of Parameter Uncertainty in Conjunction with PHysiologically-Based Pharmacokinetic Modeling. Risk Analysis, 1995. 15(5): p. 555-565.

Cullen, A.C., The sensitivity of Probabilistic Risk Assessment Results to Alternative Model Structures: A Case Study of Municipal Waste Incineration. Air & Waste Management Association, 1995. 45(July 1995): p. 538-546.

Cullen, A.C., Measures of Compounding Conservatism in Probabilistic Risk Assessment. Risk Analysis, 1994. 14(4): p. 389-393.

Dakins, M.E., et al., Risk-Based Environmental Remediation: Bayesian Monte Carlo Analysis and Expected Value of Sample Information. Risk Analysis, 1996. 16(1): p. 67- 79.

Davis, J.W., The Use of Sand Substitution to Solve the Free Silica Problem in Foudry Atmospheres. American Industrial Hygiene Association, 1979. 40: p. 609-618.

Davis, M.L. and D.A. Cornwell, Introduction to Environmental Engineering. second ed. Water Resources and Environmental Engineering, ed. McGraw-Hill. 1991, New York: PWS Publishers.

Dicke, J.L., Meteorological Factors Affecting Atmospheric Pollutants, Environmental Protection Agency, Air Pollution Control Office: North Carolina.

DiCristofaro, D.C., D. Pederson, and S. McCarthy. Assessing Health risk Uncertainty at a PCB Thermal Incinerator. in 87th Annual Meeting & Exhibition, 1994. Cincinnati, Ohio.

Doerr, W.W., Plan for the Future with Pollution Prevention. Chemical Engineering Process, 1993: p. 24-29.

Ducos, P., et al., Occupational Exposure to Volatile Nitrosamines in Foundries Using the "Ashland" Core-Making Process. Environmental Research, 1988. 47: p. 72-78.

Easterly, T.W. Measurement Based Coke Oven Battery Emission Factors. in 88th Annual Meeting 7 Exhibition, 1995. san Antonio, Texas.

Eklund, B.M. and J. Padgett. Overview of Recently Developed Guidance for Performing Air Pathway Assessments. in 86th Annual Meeting & Exhibition, 1993. Denver, Colorado.

Emory, M.B., et al., Nitrogen-Containing Compounds in Foundry Mold Emissions. American Industrial Hygiene Association, 1978. 39(7/78): p. 527-533.

Eschenroeder, A.Q. and E.J. Faeder, A Monte Carlo Analyisis of Health Risks from PCB-Contaminated Mineral Oil Transformer Fires. Risk Analysis, 1988. 8(2): p. 291-297.

Euvrard, R. and B. Jackson, Case Study: Air Audit at a Medium Size Gray Iron Foundry, 1992, A.F.S.

Evans, J.S., et al., A distributional Approach to Characterizing Low-Dose Cancer Risk. Risk Analysis, 1994. 14(1): p. 25-34.

F.Pasquill, D.S., Atmospheric Diffusion - The Dispersion of Wind-borne Material from Industrial and other Sources, ed. D.V.N.C. LTD, 1962. London W.14, England.

Federal Register, Rules and Regulations. Federal Register, 1994. 59(180): p. 47987-48003.

Ferrante, L., Waste minimization. The National Environmental Journal, 1995. (September/October): p. 36-43.

Finley, B. and D. Paustenbach, The Benefits of Probabilistic Exposure Assessment: Three Case Studies Involving Contaminated Air, Water, and Soil. Risk Analysis, 1994. 14(1): p. 53-73.

Finley, B., et al., Recommended Distributions for Exposure Factors Frequently Used in Health Risk Assessment. Risk Analysis, 1994. 14(4): p. 533-553.

Finley, B., P. Scott, and D. Mayhall, Develpment of Standard Soil-to-Skin Adherence Probability Density for Use in Monte Carlo Analysis of Dermal Exposure. Risk Analysis, 1994. 14(4).

Finley, B.L., P. Scott, and D.J. Paustenbach, Evaluating the Adequacy of Maximum Contaminant Levels as Health-Protective Cleanup Goals: An Analysis Based on Monte Carlo Techniques. Regulatory Toxicology an Pharmacology, 1993. 18: p. 438-455.

Fisher, A., A. Chitose, and P.S. Gipson, One agency's Use of Risk Assessment and Risk Communication. Risk Analysis, 1994. 14(2): p. 207-212.

Fleischman, M., et al., Waste Minimization Assessment for a Manufacturer of Iron Castings and Fabricated Sheet Metal Parts. EPA Environmental Research Brief, 1995. 83. Frederick, E.R., ed. Proceedings Atmospheric Depostion Specialty Conference. , ed. A.P.C. Association, 1982. Publishers Choice Book Mfg. Co.: Detroit. 476.

Freeman, D.L., et al., A Method for Propagating Measurement Uncertainties through Dispersion Models. Air Pollution Control Associaton, 1986. 36(3): p. 246-253.

Frey, C.H. Bootstrap Methods for Quantitative Analysis of Variability and Uncertainty in Exposure and Risk Assessment. in Air & Waste Management Association Annual Meeting. 1997. Toronto, Antario, CANADA: A&WMA.

Frey, C.H. Quantitative Analysis of Uncertainty and Variability in Exposure and Risk Assessment: Some Guidance on Why and How. in 87th Annual Meeting & Exhibition, 1994. Cincinnati, Ohio.

Frey, C.H. and D.S. Rhodes, Characterizing, Simulating, and Analyzing Variability and Uncertainty: An Illustration of Methods Using an Air Toxics Emissions Example. Human Ecological Risk Assessment, 1996. 2(4): p. 762-797.

Frey, H.C. and A.C. Cullen. Distribution Development for Probabilistic Exposure Assessment. in 88th Annual Meeting 7 Exhibition, 1995. Ssan Antonio, Texas.

Frye, R.S., Parke, and Chadbourne, What to Expect from the New Clean Air Act, in Modern Casting, 1991. p. 29-31.

Gaylor, D.W. and J.J. Chen, A Simple Upper Limit for the Sum of the Risks of the Components in a Mixture. Risk Analysis, 1996. 16(3): p. 395-398.

Gaylor, D.W., et al., Point Estimates of Cancer Risk at Low Doses. Risk Analysis, 1994. 14(5): p. 843-850.

Gaylor, D.W. and Q. Zheng, A Note on the Relationship Between Lifetime Tumor Risk and Expected Time to Tumor. Risk Analysis, 1997. 17(1): p. 5-7.

Gaylor, D.W. and Q. Zheng, Risk Assessment of Nongenotoxic Carcinogens Based upon Cell Proliferation/Death Rates in Rodents. Risk Analysis, 1996. 16(2): p. 221-225.

Georgopoulos, P.G., et al., Integrated Exposure and Dose Modeling and Analysis System. 1. Formulation and Testing of Microenvironmental and Pharmacokinetic Components. Environmental Science & Technology, 1996. 31(1): p. 17-27.

Graham, J. Modeling Coke Oven Fugitives in Complex Terrain. in 88th Annual Meeting & Exhibition, 1995. San Antonio, Texas.

Graham, J., et al., Role of Exposure Databases in Risk Assessment. Archieves of Environmental Health, 1992. 47(6): p. 408-420.

Gratt, L.B. and W.R. Chappell. Problems with the Use of Meta Analysis of Epidemiological Studies in Ris Assessment: Worker Environmental Tobacco Smoke Lung Cancer Risk as an Example. in 88th Annual Meeting 7 Exhibition, 1995. San Antonio, Texas.

Gratt, L.B. and L. Levin. An Analysis of Dispersion Model Options in the Comprehensive Risk Evaluation of Electric Utility Air Toxic Emissions. in 88th Annual Meeting & Exhibition, 1995. San Antonio, Texas.

Grisinger, J.E. and J.C. Marlia, Development and Application of Risk Analysis Methods to Stationary Sources of Carcigenic Emissions for the Regulatory Purpose by the South Coast Air Quality Management District. Air & Waste Management Association, 1994. 44(February): p. 145-152.

Grosjean, E., E.L. Williams II, and D. Grosjean, Ambient Levels of Formaldehyde and Acetaldehyde in Atlanta, Georgia. Air & Waste Management Association, 1993. 43(April 1993): p. 469-474.

Gschwandtner, G. and S. Fairchild, Emission Factors for Iron Foundries - Criteria and Toxic Pollutants, 1990. E.H. Pechan & Associates, Inc.: Durham, NC.

Guth, D.J. Acute Exposure -Response Assessment for 1,1,1-Trichloroethane Using Stratified Ordinal Regression. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Gwin, C.H., W.D. Scott, and R.H. James, A Preliminary Investigation of the Organic Chemical Emissions from Green Sand Pyrolysis. American Industrial Hygiene Association, 1976. 37: p. 685-688.

Haas, C.N., Importance of Distributional Form in Characterizing Inputs to Monte Carlo Risk Assessments. Risk Analysis, 1997. 17(1): p. 107-113.

Haimes, Y.Y., T. Barry, and J.H. Lambert. When and How Can You Specify a Probabilty Distribution When you Don't Know Much? in Workshop by The U.S. Environmental Protection Agency and the University of Virginia, 1993. Charlottesville, Virginia: Risk Analysis.

Hamed, M.M. and P.B. Bedient, On the effect of Probabilty Distributions of Input Variabilty in Publick Health Risk Assessment. Risk Analysis, 1997. 17(1): p. 97-105.

Hansen, L., MSc, J. Sollenberg, PhD, and C. Uggla, Determination of Dimethylethylethylamine in Air Samples from Iron Foundries by Isotachophoresis. Scandanavian Journal of Work Environmental Health, 1985. 11: p. 307 -310.

Harrington, N.W., C.L. Curry, and S.P. Price. The MicroExposure Event Modeling Approach to Probabilistic Exposure Assessment. in 88th Annual Meeting 7 Exhibition, 1995. san Antonio, Texas.

Hayes, A.W., Principles and Methods of Toxicology. Third Edition ed, ed. A.W. Hayne. Vol. 1, 1994. New York: Raven Press. 1400.

Hayes, L.C. and G.D. McCutchen. Averaging Times: Myths and Misunderstandings. in 88th Annual Meeting 7 Exhibition, 1995. San Antonio, Texas.

Hayes, S., et al. Assessing Exposure to Airborne Particulate Matter. in 89th Annual meeting & Exhibition. 1996. Nashville, Tennessee.

Heinhold, D.W. and K.C. Takacs. screening Versus Refined Modeling for Risk Management Planning. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Hertz, D.B. and H. Thomas, Risk Analysis and its Applications. First ed, ed. J.W. Sons. Vol. 1, 1983. Chichester . New York . Brisbane . Singapore: The Pitman Press Ltd. 323.

Hilaly, A.K. and S.K. Sikdar, Pollution Balance: A New Methodology for Minimizing Waste Production in Manufacturing Processes. Air & Waste Management Association, 1994. 44: p. 1303-1308.

Hiltman, M.M., A practical Approach to Compliance with the HON MACT. Chemical Engineering Society, 1995(March): p. 90-98.

Hoover, S.M., et al., Improving the Regulation of Carcinmogens by Expediting Cancer Potency Estimation. Risk Analysis, 1995. 15(2): p. 267-280.

Hosler, A.D., T.N. Grosshandler, and R. Lee Marchman, Fugitive Emissions: The Need for More Accurate Measurement Techniques, 1992. Air & Waste Management Association (June 1992).

Howe, E.A. and G.K. Anderson. Guide to the Environmental Backroads of the Information Highway. in 88th Annual Meeting 7 Exhibition, 1995. san Antonio, Texas.

Humphreys, M.P. and E.M. Atkins. Atmospheric Dispersion Modeling od Hazardous Air Pollutant Emissions from DOE Oak Ridge Reservation Facilities. in 88th Annual Meeting 7 Exhibition, 1995. San Antonio, Texas.

Ibrekk, H. and M.M. Granger, Graphical Communication of Uncertain Quantities to Nontechnical People. Risk Analysis, 1987. 7(4): p. 519-529.

Iman, R.L. and J.C. Helton, An Investigation of Uncertainty and Sensitivity Analysis Techniques for Computer Models. Risk Analysis, 1988. 8(1): p. 71-90.

Jeffrey, J., J. Fitzgerald, and P. Wolf, Gray Iron Foundry Industry Particulate Emissions: Source Category Report, 1986. GCA Corporation, Technology Division: Bedford, MA.

Johnson, T., et al., A Comparison of Ten Time/Activity Databases: Effects of Geographic Location, Temperature, Demographic Groups, and Diary Recall Method, 1993.

Johnson, T., M.J. McCoy, and W.M. Ollison. A Monte Carlo Approach to generating Equivalent Ventilation rates in Population Exposure Assessments. in 88th Annual meeting 7 Exhibition, 1995. san Antonio, Texas.

Jurczyk, N., C. Marcussen, and W. Tucker, Risk Assessment: A Tiered Approach. The National Environmental Journal, 1995: p. 20-22.

Kaiser, G.D., J.S. Touma, and D. Christensen. Contingency Modelong Analysis for Superfund Sites and Other Industrial Sources. in 86th Annual Meeting & Exhibition, 1993. Denver, Colorado.

Kao, A.S., Formation and Removal Reactions of Hazardous Air Pollutants. Air & Waste Management Association, 1994. 44(May 1994): p. 683-697.

Keil, C.B., P.A. Scheff, and R.A. Wadden. Receptor Model Evaluation of Fugitive ink Emissions for Heatset Offset Press. in 88th Annual Meeting 7 Exhibition, 1995. San Antonio, Texas.

Kelly, T.J., et al., Concentrations and Transformations of Hazardous Air Pollutants. Environmental and Science Technology, 1994. 28(8): p. 378A-387A.

Kennedy, D.O. and L.B. Knight, Market Drives Automotive Castings to Aluminum. Modern Casting, 1992(February 1992): p. 34 - 36.

Klafka, S. and J. Loeffle. Measurement of Organic Toxics at Iron Foundry. in 88th annual Meeting & Exhibition, 1995. san Antonio, Texas.

Klafka, S.J., Air Toxic Control Alternatives for Foundry Pouring, Cooling and Shakeout Operations. Air & Waste Management Association, 1992 (June 1992).

Knecht, U., H.J. Elliehausen, and H.J. Woitowitz, Gaseous and adsorbed PAH in an iron foundry. British Journal of Industrial Medicine, 1986. 43(March 1986): p. 834 - 838.

Kornegay, B., G. Lanham, and G. Mosher, Clean Air Act Needs Planning, Concerted Action. Modern Casting, 1991(July 1991): p. 43-45.

Kumar, A., R. Madasu, and A. Mahurkar, A Review of AIRSCAPE Program for the ISC2 Model. Environmental Progress, 1995. 14(2): p. M13-M15.

Kumar, A., S. Wiedenbaum, and M. Woodman, Quick Estimates for Hazardous-Gas Releases. Environmental Engineering World, 1995(September-October): p. 29-31.

Leroux, B.G., et al., A Biologically-Based Dose-Response Model for Developmental Toxicology. Risk Analysis, 1996. 16(4): p. 449-458.

Levin, L., et al. Utility Industry-Wide Risk assessment of Trace Substances: results. in 88th Annual meeting 7 Exhibition, 1995. san Antonio, Texas.

Li, R., M. Karell, and J.W. Boddy, Develop A Plantwide Air Emissions Inventory. Chemical Engineering Progress, 1995: p. 96-103.

Librizzi, W.J. and C.N. Lowery, eds. Hazardous Waste Treatment Processes Including Environmental Audits and Waste Reduction, 1990. Water Pollution Control Federation. 327.

Lindley, D.V., Making Decisions. Second ed, ed. J.W. Sons. Vol. 1, 1985. London . New York . Toronto . Singapore. 207.

Lioy, P.J., Assessing total human exposure to contaminants. Environ. Sci. Technol, 1990. 24(7): p. 938-945.

Lipfert, F.W., L. Saroff, and P.D. Moskowitz. Issues in Assessment of Congenital Health Risks from Mercury in Coal. in 88th Annual meeting 7 Exhibition, 1995. San Antonio, Texas.

Lorentzen, R.J., FDA Procedure for Carcinogenic Risk Assessment. Food Technology, 1984 (October 1984): p. 108-111.

Mahoney, L.A., M.D. Petroff, and J.C. Batey. Using Modeled Ecological Risks as a Basis for Sediment Cleanup Levels. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Mattie, D.R., J.H. Grabo, and J.N. McDougal, Significance of the Dermal Route of Exposure to Risk Assessment. Risk Analysis, 1994. 14(3): p. 277-284.

Maurin, P.G., Controlling SO2 Emissions. A Look at Wet and Dry Flue Gas Desulfurization Systems. PLANT ENGINEERING, 1985(7550): p. 52-56.

Maysilles, J., Review of Foundry Emissions Data, 1993. US EPA Foundry MACT Project.

McDermott, H.J., Handbook of Ventillation for Contaminent control, 1985. Boston, Butterworth.

McDonald-Buller, E.C., H.M. Liljestrand, and K. Sepehrnoori. Numerical Modeling of Dry Deposition Coupled to Seventeen Photochemical Reactions. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

McKenley, M.D., Air Emissions from Permanent Mold Casting of Ductile Iron Pipe, 1994. The University of Alabama: Tuscaloosa, Alabama.

McKenley, M.D., et al., Air Emissions from Foundries: A Current Survey of Literature, Suppliers and Foudrymen. AFS Transactions, 1990: p. 979-990.

McKone, T. and K. Bogen, Uncertainty in Health Risk Assessment: An Integrated Case Study Based on Tetrachloroethylene in California Groundwater. Regulatory Toxicological Pharmacology, 1992. 15: p. 86-103.

McKone, T.E. Uncertainty Versus Variability in Monte Carlo Simulations of Human Exposure Through Food Pathways. in 87th Annual Meeting & Exhibition, 1994. Cincinnati, Ohio.

McKone, T.E. and K.T. Bogen, Predicting the Uncertainties in Risk Assessment. Environmental Science and Technology, 1991. 25(10): p. 1674-1681.

McTigue, J. and R. Dwyer, Cleaning up Risk Assessment. ENR Special Advertising Section, 1995: p. E-17 -18.

Michaud, D., M. Baril, and G. Perrault, Characterization of Airborne Dust from Cast Iron Foudries by Physico-Chemical Methods and Multivariabte Statistical Analysis. Air & Waste Management Association, 1993. 43(May): p. 729-735.

Middlekauff, R.D., Risk Analysis and the Interface of Science, Law, and Policy. Food Technology, 1984(October 1984): p. 96=106.

Miller, S.S., NAPAP: A Unique Experience. Environmental Science & Technology, 1990. 24(12): p. 1781-1782.

Mitchell, W.J. and M.R. Midgett, Measuring Inorganic and Alkyl Lead Emissions from Stationary Sources. Journal of the Air Pollution Control Association, 1979. 29(9): p. 959 - 962.

MOH, MDI in the foundry. Michigan's Occupational Health, 1966. 11(4): p. 2-6.

Mookherjea, A., Air Pollution Control with Special Reference to Foundries. INDIEN FOUDRY JOURNAL, 1986: p. 15 -24.

Moore, G., et al. Model Performance Evaluation of Gaseous Dry Deposition Algorithms. in 88th Annual meeting 7 Exhibition, 1995. san Antonio, Texas.

Mosher, G., AFS Title V Seminar, January 24 - 25, 1995, 1995. American Founddrymen's Society, Inc.

Mosher, G.E., Environmental:'What's Hot & What's Not", in Modern Casting, 1991. p. 32.

Mosher, G.E., Calculating Emission Factors for Pouring, Cooling and Shakeout. Modern Casting, 1994: p. 28-31.

Mukund, R., et al., Status of Ambient Measurement Methods for Hazardous Air Pollutants. Environmental Science & Technology, 1995. 29(4): p. 183A-187A.

Murray, D.M. and D.E. Burmaster, Residential Air Exchange Rates in the United States: Empirical and Estimated Parametric Distributions by Season and Climatic Region. Risk Analysis, 1995. 15(4): p. 459-465.

Nand, K., M. Olmos, and H. Rous. Use of Mechanical Mixing Height for Performing Health Risk Assessments of Hazardous Air Pollutant emitting Facilities. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

NAS, Human Exposure Assessment for Airborne Pollutants - Advances and Opportunities, ed. N.A.O. Science, 1991. Washington, D.C.: National Academy Press. 321.

NESHAP, Documentation for Developing the Source Category List, 1990. U.S.E.P.A.: Research Triangle Park.

Nilan, T.J. Characterization of Emissions from Iron and Steel Plants. in 88th Annual meeting & Exhibition. 1995. san Antonio, Texas.

NTIS, N.T.I.C., Organic Emissions from Ferrous Metallurgical Industries Compilation of Emission Factors and Control Technologies, 1984. Industrial Environmental Research Lab. Research Triangle Park, NC: New York City.

Oman, D.E., Waste Minimization in the Foundry Industry. JAPCA, 1988. 38(7): p. 932 - 940.

Ott, W.R., Environmental Statistics and Data Analysis, ed. I. CRC Press, 1995. Ann Arbor, MI: Lewis Publishers. 313.

Pai, P., S. Heiler, and P. Karamchandani. A Three-Dimensional, Eulerian Modeling Study to Evaluate Health Risks from Hazardous Air Pollutants in Arizona. in 89th Annual meeting & Exhibition, 1996. Nashville, Tennessee.

Paine, R.J. Evaluation of Building Downwash Models with Several Data Bases. in 89th Annual Meeting & Exhibition. 1996. Nashville, Tennessee.

Palisade, @RISK, . 1997, Palisade Corporation: Newfield, NY.

Palmer, W.G., R.C. Scholz, and W.J. Moorman, An Innovative Approach to Sampling Complex Industrial Emissions for Use in Animal Toxicity Tests: Application to Iron Casting Operations. American Industrial Hygiene Association, 1983. 44(3): p. 184-189.

Patrick, D.R., ed. Toxic Air Pollution Handbook. 1994, Van Nostrand Reinhold International Thomson Publishing Company: New York.

Paustenbach, D.J., Risk Assessment of Environmental and Human Health Hazards: A Textbook of Case Studies, 1989. Alameda: John Wiley & Sons. 1155.

Paustenbach, D.J., et al., An Assessment and Quantitative Uncertainty Analysis of Health Risks to Workers Exppposed To Chromium Contaminated Soils. Toxicology and Industrial Health, 1991. 7(3): p. 159-196.

Paustenbach, D.J., et al., Recent Developments on the Hazards Posed by 2,3,7,8-Tetrachlorodibenzo-p-dioxin in Soil: Implications fpr Setting Risk-based Cleanup Levels at Residential and Industrial Sites. Journal of Toxicology and Environmental Health, 1992. 18: p. 103-149.

Paxton, M.B., et al., Leukemia Risk Associated with Benzene Exposure in the Pliofilm Cohort: II. Risk Estimates. Risk Analysis, 1994. 14(2): p. 155-161.

Paxton, M.B., et al., Leukemia Risk Associated with Benzene Exposure in the Pliofilm Cohort: I. Mortality Update and Exposure Distribution. Risk Analysis, 1994. 14(2): p. 147-154.

Pechan, E.H. and associates, Air Toxic Emissions Fron Iron Foudries, 1991. U.S.EPA: Research Triangle Park.

Pennington, R.L., A Smorgasbord of VOC and HAP Control Options. Environmental Protection, 1996(November 1996): p. 32-34.

Peterson, R.L. Objective Method for Estimating Surface Roughness Length for Dispersion Modeling Applications. in 88th Annual meeting 7 Exhibition, 1995. San Antonio, Texas.

Peterson, T.N., P.E., Best Available Control Technology Assessment for Wisconsin Cast Metals Association, 1991. RMT, Inx: Madison, Wisconsin.

Potokar, R.W., Foundry Process Air Recirculation. Journal of the Air Pollution Control Association, 1979. 29(1): p. 18 - 20.

Price, P.S., et al., Monte Carlo Modeling of Time-Dependent Exposures Using a Microexposure Event Approach. Risk Analysis, 1996. 16(3): p. 339-348.

Quiring, S.J. and L. Brahce. Risk Assessment as a Tool for Identifying and Managing Environmental Risks-Case Study. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Radia, J.T., Environmental Considerations in the use of coal-dust substitutes, 1975. BCIRA. 195. Rao, S., Z. Boybeyi, and S. Raman. A Study of Low Wind Speed Diffusion in the Tropics Using a 3D Lagrangian Dispersion Model. in 88th Annual meeting 7 Exhibition. 1995. san Antonio, Texas.

Rappaport, S.M. and T.J. Smith, Exposure Assessment for Epidemiology and Hazard Control. first ed. Industrial Hygiene Science, ed. A.C.o.G.I. Hygienist. Vol. 1. 1991, Chelsea, MI 48118: Lewis Publishers, INC. 313.

Razzaghi, M. and D.W. Gaylor, On the Correlation Coefficient Between the TD50 and the MTD. Risk Analysis, 1996. 16(1): p. 107-113.

Renman, L., C. Sango, and G. Skarping, Determination of Isocyanate and Aromatic Amine Emissions from Thermally Degraded Polyurethanes in Foundries. Journal of American Industrial Hygiene Association., 1986. 47(October): p. 621-628.

Renner, R., Predicting Chemical Risks with Multimedia Fate Models. Environmental Science & Technology, 1995. 29(NO 12): p. 556A-559A.

Renner, R., when is Lead a Health Risk? Environmental Science and Technology, 1995. 29(6): p. 256A-261A.

Rickun, J.S. and M. Sorenson, Economic Evaluation of Control Devices for Benzene and Formaldehyde Emissions from Casting Operations. Air & Waste management Association, 1992(June 1992).

Rivkin, C. and A. Roffman. MACT Analysis for Major Uncontrolled Sources Not Yet Subject to a MACT Standard. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Rod, L., VOC, HAP's Control Systems Compared. Environmental Protection, 1994: p. 56-76.

Rosenman, K.D., et al., 1994 Annual Report on Silicosis in Michigan, 1995. Michigan State University Dept. of Medecine and the Department of Public Health: Lansing.

Rossiter, A.P. and J.D. Kumana, Rank Pollution Prevention and Control Options. Chemical Engineering Progress, 1994: p. 39-44.

Rossiter, A.P., H.D. Spriggs, and H. Klee Jr., Apply Process Integratiion to Waste Minimization. Chemical Engineering Progress, 1993: p. 30-36.

Santos, S.L., V.T. Covello, and D.B. McCallum, Industry Response to SARA Title III: Pollution Prevention, Risk Reduction, and Risk Communication. Risk Analysis, 1996. 16(1): p. 57-66.

Schimberg, R.W., P. Pirkko, and A. Tossavainen, Polycyclic Aromatic Hydrocarbons in Foundries. Journal of Toxicology and Environmental Health, 1980. 6(516): p. 1187-1194.

Schnatter, R.A., M.J. Nicolich, and M.G. Bird, Determination of Leukemogenic Benzene Exposure Concentrations: Refined Analyses of Pliofilm Cohort. RisK Analysis, 1996. 16(6): p. 833-840.

Scott, W.D. and C.E. Bates, PhD, Measurement of Iron Foundry Fugitive EMissions, in Symposium on Fugitive Emissions Measurement and Control. 1976, US EPA: Hartford, CT.

Scott, W.D. and C.E. Bates, Decomposition of Resin Binders and the Relationship Between Gases Formed and the Casting Surface Quality. AFS Transactions, 1975. 103: p. 519-524.

Scott, W.D., C.E. Bates, and R.H. James, Chemical Emissions from Foundry Molds. AFS Transactions, 1977. 98: p. 203-208.

Scott, W.D. and R.C. Commisford, Core Room Emissions in Foudries, 1978. Southern Research Institute. Birmingham, AL: San Francisco, CA.

Scott, W.D. and C.E. Feazel, A Review of Organic Sand Binder Chemistry, 1976, Southern Research Institute: Birmingham, Alabama.

Scott, W.D., R.H. James, and C.E. Bates, Foundry Air Contaminants from Green Sand Molds. American Industrial Hygiene Association, 1976: p. 335-343.

Sedman, R.M. and M. R.J., Soil Ingestion by children and Adults Reconsidered Using the Results of Recent Tracer Studies. Air and Waste Management Association, 1994. 44(February): p. 141-144.

Seed, L.P. and R.L. Corsi. Biofiltration of Benzene, Toluene, and o-Xylene: Substrate Effects and Carbon Balancing. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Seifert, D., Preparing a HON Subpart G Compliance Program. Environmental Protection, 1995(March): p. 30-32.

Seigneur, C., et al., The Use of Health Risk Assessment to Estimate Desirable Sampling Detection Limits. Air & Waste Management Association, 1995. 45(October 1995): p. 823-830.

Seiler, F.A. and J.L. Alvarez, On the Selection of Distributions for Stochastic Variables. Risk Analysis, 1996. 16(1): p. 5-18.

Selchan, D., Process Description, Health Hazards, and Control Measures in the Foundry Industry. Ashland Chemical, 1996.

Sexton, K., K.S. Liu, and M.X. Petreas, Formaldehyde Concentrations Inside Private Residences: A Mail-Out Approach to Indoor Air Monitoring. Journal of the Air Pollution Control Association, 1986. 36(6): p. 699-704.

Shlyakhter, A.I., An Improved Framework for Uncertainty Analysis: Accounting for Unsuspected Errors. Risk Analysis, 1994. 14(4): p. 441-447.

Sigal, E.A., et al. The Role of Risk Assessment in Military Base Closures. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Simmons, S.A., Estimating Heavy Metal Emiossions from iron Foundry Cupola Furnaces. CLEAN AIR, 1983. 12 (4): p. 127-137.

Slob, W., A Comparison of Two Statistical Approaches to Estimate Long-Term Exposure Distributions from Short-Term Measurements. Risk Analysis, 1996. 16(2): p. 195-200.

Slob, W., Uncertainty Analysis in Multiplicative Models. Risk Analysis, 1994. 14(4): p. 571-576.

Small, M.J. Invariabily uncertain about Variability? Try the Normal-Gamma Conjugate! in 87th Annual Meeting & Exhibition, 1994. Cincinnati, Ohio.

Smith, D.G. and D. Heimold. Deposition Modeling for Dioxins/Furans: Realistic Alternatives to the 1993 EPA Addendum Approach for Plant Uptake of Vapors and Particles. in 88th Annual Meeting 7 Exhibition, 1995. san Antonio, Texas.

Smith, M.V., Use of Risk Assessment in Regulatory Decision-Making. Food Technology, 1984(October 1984): p. 113=122.

Smith, R.L., Use of Monte Carlo Simulation for Human Exposure Assessment at a Superfund Site. Risk Analysis, 1994. 14(4): p. 433-439.

Smith, T.J., American Journal Ind. Med., 1992(21): p. 35-51.

Sohr, R.T., Economical Effectiveness of Chemical Absorption on the Removal of Smoke and Ododr from Various Coremaking, Pouring, Cooling and Shakeout Operations. AFS Transactions, 1975. 30: p. 401-402.

Stefanescu, D.M., ed. ASM Handbook. . Vol. 15. 1988.

Stevens, J.B., et al. Health Risk Analyses Using Receptor Modeling of Ambient Air Sampling Results. in 88th Annual meeting 7 Exhibition, 1995. san Antonio, Texas.

Stine, K.E. and T.M. Brown, Principles of Toxicology, ed. I. CRC Press. 1996: Lewis Publishers. 259.

Stock, T.H., Formaldehyde Concentrations Inside Conventional Housing. JAPCA, 1987. 37(8): p. 913-918.

Strickland, J.A. Do Concentration-Toxicity Screens Eliminate Risky Chemicals from Cumulative Risk Estimates? in 89th Annual Meeting & Exhibition. 1996. Nashville, Tennessee.

Sung, H. A Qualitative Evaluation of the ISCST3 Area Source and Dry Deposition Algorithms. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Swaminathan, R., M.K. Reddy, and N.S. Manthapurwar, Cupola Emissions in Iron Foundries - A Case Study, 1983. National Environmental Engineering Research Institute Nagpur, India: Atlanta, Georgia.

Tabak, H.H., et al. Development of Bioavailability and Biokinetics Models for Soil Protocol to Phenol and Polycyclic Aromatic Hydrocarbon Soil Pollutants. in 89th Annual meeting & Exhibition. 1996. Nashville, Tennessee.

Tabak, H.H., et al. Biokinetics and Bioavailability Protocol for Organic Pollutants in Soil to Enhance Bioremediation. in 89th Annual Meeting & Exhibition. 1996. Nashville, Tennessee.

Tardif, R., et al., Physiologically-Based Pharmacokinetic Modeling of a Mixture of Toluene and Xylene in Humans. Risk Analysis, 1995. 15(3): p. 335-342.

Taylor, R.K. Evaluation of ISCST3 Dispersion Model Performance Using Actual Emissions Data and Ambient Monitoring Data for a Large Chemical Manufactoring Facility Located in North Carolina. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Thompson, K.M., D.E. Burmuster, and E.A.C. Crouch, Monte Carlo Thechniques for Quantitative Uncertainty Analysis in Public Health Risk Assessments. Risk Analysis, 1992. 12(1): p. 53-63.

Thsi, Environmental Assessment of Iron Casting(1980) or Emissions Factors for Iron Foundries-Criteria and Toxic Pollutants, 1990: Hamilton County, Chattanooga, Tennessee.

Toeniskoetter, R.H. and R.J. Schafer, Industrial Hygiene Aspects of the Use of Sand Binders and additives, 1978. Ashland Chemical Co, USA.

Topazio, R.J., How to Conduct An Emissions Inventory. Environmental Protection, 1994(July): p. 28-34.

Tossavainen, A., ed. Estimated Risk of Lung Cancer Attributable to Occupational Exposures in Iron and steel foundries. Lung Cancer Risk in Foundry Work, ed. I.A.F.R.O. Cancer, 1990. IARC: Lyon, France. 363-367.

Tossavainen, A., Metal Fumes in Foundries. Scand. j. Work environ. & helth 2, 1976. 1: p. 42-49.

Touma, J.S. Developments in EPA'S Air Dispersion Modeling for Hazardous /Toxic Releases. in 88th Annual meeting 7 Exhibition, 1995. san Antonio, Texas.

Touma, J.S., M.W. Eltgroth, and S.M. Templeman. Procedures for Air Dispersion Modeling at Superfund Sites. in 88th Annual Meeting 7 Exhibition, 1995. san Antonio, Texas.

Trombly, J., Recasting a Dirty Industry. Environmental Science & Technology, 1995. 29(2): p. 76-78.

Turner, D.B., Workbook of Atmospheric Dispersion Estimates, 1967. Department of Health and Welfare: Cincinnati, Ohio.

Turner, D.B. and L.W. Bender, Description of UNAMAP (VERSION 6). Environmental Research Brief, 1986(Dec. 1986).

Twarog, D.L., Identification of Emissions and Solid Wasted Generated from EPC Pricess: Literature Review and Analysis, 1991. AFS Research report.

U.S.EPA, Summary Report for the Workshop on Monte Carlo Analysis, 1996. Office of Research and Development: New York, NY.

U.S.EPA, Evaluation of existing Approaches for Assessing Non-Inhalation Exposure and Risk with Recommendations for Implementing T.R.I.M., 1996. EPA, Office of Air Quality Planning and Standards: Durham, N. Carolina.

U.S.EPA, ed. Activity Factors. second ed. Exposure Factorrs Handbook, ed. N.C.f.E.A. Office of Research and Development, US. EPA. Vol. III., 1996. EPA: Washington DC. 14.1-G.3.

U.S.EPA, Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures, 1996. Ohio EPA: Ohio.

U.S.EPA, User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, . 1995, Office of Air Quality Planning and Standards: Research Triangle Park, NC.

U.S.EPA, ed. Integrated Risk Information Sysytem, 1997 ed. . 1997.

U.S.EPA, Risk Characterization: A Practical Guidance for NCEA-Washington Risk Assessors, 1997, NCEA-EPA: Washington DC.

U.S.EPA, ed. Food Ingestion Factors. second ed. Exposure Factorrs Handbook, ed. N.C.f.E.A. Office of Research and Development, US. EPA. Vol. II. 1996, EPA: Washington. 9.1-13.16.

U.S.EPA, ed. General Factors. second ed. Exposure Factorrs Handbook, ed. N.C.f.E.A. Office of Research and Development, US. EPA. Vol. I., 1996. EPA: Washington. 1.1-8.3.

U.S.EPA. Policy for Use of Probabilistic Analysis in Risk Assessment. in Colloquium on Implementation of the probabilistic Risk Assessment Policy, 1997. Washington DC.

U.S.EPA, Risk Assessment Guidance for Superfund - Human Health Evaluation Manual(Part B, Development of Risk-based Preliminary Remediation Goals), . 1991, EPA: Washington DC.

U.S.EPA, Risk Assessment Guidance for Superfund - Human Health Evaluation Manual, 1989, EPA: Washington DC.

U.S.EPA, Implimentation Strategy for the Clean Air Act Amendment of 1990, 1991, US Environmental Protection Agency: Washintong D.C.

U.S.EPA, Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessments, 1985, US Department of Commerce, National Technical Information Service: Washington DC.

U.S.EPA, User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), 1995, EPA.

U.S.EPA, Instant EPA's Air Toxics, 1994, Instant Sources, Inc and Digital Liaisons: Austin, Texas.

U.S.EPA, The Plain English Guide to the Clean Air Act, 1993, EPA: Washington DC.

U.S.EPA, Compilation of Air Pollutant Emission Factors, 1991, U.S. EPA: Research Triangle Park, NC.

U.S.EPA, Addendum to the Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions, 1993. Office of Research and Development: Washington DC.

U.S.EPA and N. Research Triangle Park, Environmental Assessment of Iron Casting, 1980, Industrial Environmental Research Lab.: North Carlina.

Venkatram, A., Inherent Uncertainty in Air Quality Modeling. Atmospheric Environment, 1988. 22(6): p. 1221-1227.

Venkatram, A. and C. Seigneur, Review of Mathematical Models for Health Risk Assessment:II. Atmospheric Chemical Concentrations. Environmental Software, 1993. 8: p. 75-90.

Wallace, D. and C.J. Cowherd, Fugitive Emissions from Iron Foundries, 1979. Midwest Research Institute: Kansas City.

Wallace, D.D., C.J. Cowherd, and J.S. Kinsey, Identification, Assessment, and Control of Fugitive Particulate Emissions in Foundries. AFS Transactions, 1985. 85(106): p. 727 - 735.

Wallace, L.A., The Total Exposure Assessment Methodology (TEAM) Study: Summary and Analysis: Volume 1, 1987. U.S. Environmental Protection Agency: Washington DC.

Watanabe, K.H. and F.Y. Dois, Interspecies Extrapolation of Physiological Pharmacokinetic Parameter Distributions. Risk Ananlysis, 1996. 16(6): p. 741-754.

Weaver, C.J. and A.A. Sullivan. Modeling PM10 Emissions from Coke Ovens for Allegheny County's PM10 State Implementation Plan. in 88th Annual Meeting & Exhibition, 1995. San Antonio, Texas.

Weil, J.C., L.A. Corio, and R.P. Brower. An Improved Dispersion Model for Buoyant Plimes in Convective Boundary Layer. in 88th Annual Meeting 7 Exhibition, 1995. San Antonio, Texas.

Weil, J.C.a.T., B., R. Banta, and W. Mitchell. Atmospheric Dispersion Model Development for Open Burn/Open Detonation Emissions. in 88th Annual Meeting 7 Exhibition, 1995. San Antonio, Texas.

Westbrook, J.A. and J.A. Tarde. Evaluation of Dispersion Modeling Techniques for Horizontal, Tilted, or Capped Emission Sources. in 88th Annual Meeting 7 Exhibition, 1995. San Antonio, Texas.

Wexler, P. TOXNET: An Online Resource for environmental and Toxicological Informmation. in 88th Annual Meeting 7 Exhibition, 1995. San Antonio, Texas.

Whitefield, R.G. and H.M. Richmond. Probabilistic Exposure and Health Risk Estimates for the Review of Ozone National Ambient Air Quality Standards. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Wilson, J.D., So Carcinogens Have Thresholds: How Do We Decide What Exposure Levels Should Be Considered Safe? , Risk Analysis, 1997. 17(1): p. 1-3.

Wright, J.W.G. and M.E. Henry. Hazardous Waste Combustion: Key Regulatory Developments. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Yamada, T. Numerical Simulation of Plumes from Multiple Sources in Complex Terrain. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Yi WU, C. and C.J. Twaroski. Health -Based Review of the National Emission Standards for Hazardous Air Pollutants for Source Categories: Perchloroethylene Dry Cleaning Facilities. in 89th Annual Meeting & Exhibition, 1996. Nashville, Tennessee.

Zhang, J., J. Billiet, and R. Dams, Elemental Composition and Source Investigation of Particulates suspended in the air of an iron foundry, in The Science of the Total Environment, E.S. Publishers, Editor. 1985, Elsevier Publishers: Amsterdam, The Netherlands. p. 13 - 28.

Zhang, J., et al., Survey of Total and Respirable Suspended Particulate Matter in an Iron Foundry. Comparison of stationary sampling and personal monitoring., in The Science of the Total Environment, E.S. Publishers, Editor. 1983, Elsevier Science Publishers: Amsterdam, The Netherlands. p. 167 - 180.

Zoller, J.M., G.A. Jutze, and L.A. Elfers, A Method of Characterization and Quantification fo Fugitive Lead Emissions from Secondary Lead Smelters, Ferroalloy Plants, and Gray Iron Foundries (Revised), 1978, PEDCo Environmental, Inc.: Cincinatti, Ohio.