8/1/89

to: Bob Kirkpartick
Bill Blankenship
NM EID Air Quality Bureau

C. Kelly Crossman
NM EID Hazardous Waste Bureau

from: Michael Horan
Taos tel: 758-3522

Gentlemen:

Enclosed, please find complete copies of the new U.S. EPA Guidances on Emissions for Heavy Metals, Hydrogen Chloride and for PIC (Products of Incomplete Combustion).

My comment is that I think the Heavy Metals and HCl guidance is bewildering in its complexity and will never be put into practical application anywhere. Also, it provides too many loopholes by allowing calculation of emissions from the feed material.

and LAER

I much prefer a technology based BACT derived stack gas volume concentration emissions limit such as Shiva Garg has done with the PIC emissions limit.

Surprisingly, there have been -0- BACT determinations by U.S. EPA for hazardous waste incinerators. I also understand that EPA Region6 has never ordered a stack gas simple for heavy metals on any incinerator in their region.

8581

HC and PIC

My argument is to go with a straight LAER & BACT technology based stack gas emissions limit and let the vendor companies fight it out in the marketplace as to who has the cleanest equipment.

I mean NO_x automobile emissions are limited at the exhaust pipe, right? So why can't you limit heavy metals and radionuclides at the stack on the TA-50 TRU waste incinerator.?

I sincerely can't imagine the EPA Heavy Metals and HCl guidance feed material calculations every being done anywhere except perhaps in an EPA workshop.

The EPA sampling protocols are child's play by comparison, so why not assign the stack gas limit and the corresponding sampling protocol and be done with it?

Sincerely,

Michael Horan

Michael Horan
tel: 758-3522
Taos

Encls: complete copies
U.S. EPA Guidances on Heavy Metals, HC and PIC

United States
Environmental Protection
Agency

Office of
Solid Waste
Washington, DC 20460

EPA/
March 1989

Hazardous Waste Incineration

EPA

Guidance on Metals and Hydrogen Chloride Controls for Hazardous Waste Incinerators

Volume IV of the Hazardous Waste Incineration Guidance Series

DRAFT

D-1 D-3

United States Environmental Protection Agency

Office of Solid Waste Washington DC 20460

EPA August 1989

Hazardous Waste Incineration

EPA

Guidance on Metals and Hydrogen Chloride Controls for Hazardous Waste Incinerators

Volume IV of the Hazardous Waste Incineration Guidance Series

Table of Contents

Introduction....1
Background and Purpose....1
Overview of Guidance....2
Authority....4
Structure of this Document....5

Tab A: Data Gathering, Terrain Analysis, and Applicability of Screening Tables....1
Step 1: Gather Source Data (from Applicant)....2
Step 2: Determine Land Use Characteristics (using the Auer Method)....3

Tab B: Determine Feed Rates or Emission Limits (Tier I and Tier II)....1
Step 1: Determine Worst-Case Stack for Multiple Stack Sites....2
Step 2: Define Terrain....2
Step 3: Determine Terrain-Adjusted Effective Stack Height....3
Step 4a: Determine Compliance with Tier I Feed Rate Limits....5
Step 4b: Determine Compliance with Tier II Emission Limits....7

Tab C: Site-Specific Modeling and Risk Analysis (Tier III)....1
Step 1: The Permit Writer Determines Whether to Require the Applicant to Conduct Site-Specific Dispersion Modeling....4
Step 2: Applicant must Submit the Dispersion Modeling Plan for Review by the Regional Meteorologist or PAT....8
Step 3: Applicant Provides the Model Results and Risk Analysis for Review (See WORKSHEET 2 in Appendix IV)....9

Tab D: Determine Necessary Permit Conditions....1
Step 1: Determine Necessary Permit Conditions....3

Appendix I. Technical Support for the Modeling Risk Assessment
1. Background Information on the Dispersion Modeling used to Establish Emission Limits....I-1
1.1 Overview of the Modeling Approach....I-1
1.1.1 General Assumptions and Methods....I-1
1.1.2 Specific Steps of the Analysis....I-3
1.2 Facility Selection....I-4
1.3 Model Selection....I-4
1.4 Input Parameters....I-5
1.4.1 Terrain Analysis....I-5
1.4.2 Release Specifications....I-5
1.4.3 Results and Analysis....I-6
2. Urban/Rural Classification—Auer Method....I-8
2.1 Simplified Land Use Process....I-8
3. Background Information on the Health Risk Assumptions used to Establish Emission Limits....I-12
3.1 Carcinogens....I-12
3.2 Noncarcinogens....I-14

Appendix II. Using the Graphical Exposure Modeling System (GEMS)
Step-by-Step Procedures for Using GEMS
Step 1: Accessing the GEMS System and GAMS Subsystem....II-1
Step 2: Obtain Meteorological Data Requirements for ISCLT....II-1

Step 3: Consult with the Regional Meteorologist or the Permit Assistance Team (PAT)....II-2
Step 4: Identify the Worst-Case Stack....II-2
Step 5: Create the ISCLT Input File and Run the Model....II-3
Step 6: Follow up Model Runs for Greater Detail....II-5
GEMS Model Data Input/Output....II-6

Appendix III. Technical Support for Permit Conditions
1. Control Techniques and Removal Efficiencies....III-1
1.1 Air Pollution Control Devices (APCDs)....III-5
1.1.1 Electrostatic Precipitator....III-5
1.1.2 Wet Electrostatic Precipitator....III-7
1.1.2.1 Process Description....III-7
1.1.3 Fabric Filter (Baghouse)....III-7
1.1.3.2 Operation and Maintenance....III-9
1.1.4 Quench Chamber....III-9
1.1.4.1 Process Description....III-9
1.1.4.2 Operation and Maintenance....III-12
1.1.5 Wet/Dry Scrubber (Spray Dryer)....III-12
1.1.5.1 Process Description....III-12
1.1.5.2 Operation and Maintenance....III-12
1.1.6 Venturi Scrubber....III-13
1.1.6.1 Process Description....III-13
1.2 APCD Efficiencies....III-14
1.3 Metals Partitioning....III-17

Appendix IV. Worksheets for Permitters' Use
1. Instructions for Completing WORKSHEET 1....IV-1
1.1 Reference Information....IV-1
1.2 Site Information....IV-1
1.3 Requested Maximum Metal and Chlorine Feed Rates....IV-2

Appendix V. Hazardous Waste Combustion Air Quality Screening Procedure for RCRA Permit Writers
Introduction....V-1
Step 1: Obtain Permit Data....V-4
Step 2: Determine the Applicability of the Screening Procedure....V-10
Step 3: Select the Worst-Case Stack....V-12
Step 4: Verify Engineering Practice (GEP) Criteria....V-13
Step 5: Determine the Effective Stack Height and the Terrain Adjusted Effective Stack Height....V-15
Step 6: Classify the Site as Urban or Rural....V-20
Step 7: Identify Maximum Dispersion Coefficients....V-20
Step 8: Estimate Maximum Ambient Air Concentrations....V-28
Step 9: Determine Compliance with Regulatory Limits....V-30
Step 10: Multiple Stack Method (Optional)....V-32
Appendix A: Rational for the Screening Procedure....V-49
Introduction....V-49
Development of the Screening Procedure....V-49
Rational For Technical Approach / Step-By-Step Description....V-53

Introduction

GUIDANCE ON METALS AND HYDROGEN CHLORIDE CONTROLS FOR HAZARDOUS WASTE INCINERATORS

Background and Purpose

The Environmental Protection Agency has proposed amendments to the Subpart O, Part 264 hazardous waste incinerator rules. The proposal states the Agency's conclusion that emissions of metals and hydrogen chloride (HCl) from hazardous waste incinerators can pose unreasonable levels of risk, and in those cases, need to be regulated more stringently than under existing rules in order to protect human health and the environment. This guidance document is designed to enable the permit writer to exercise his authority under Section 3005(c)(3) of the Resource Conservation and Recovery Act to develop permit requirements as may be necessary to ensure that metals and HCl emissions do not pose unacceptable risk to human health and the environment.

This document sets out ways of implementing controls for metals and HCl emissions consistent with the proposed rule. The approach is intended to ensure that emissions of individual metals and HCl reaching a hypothetical maximum exposed individual (MEI) do not exceed ambient health-based levels[1] The Agency has proposed these health-based levels (known as Risk-Specific Doses (RSDs) for carcinogens and Reference Air Concentrations (RACs) for noncarcinogens) for public comment. Permit applicants could demonstrate compliance with these ambient levels by emissions testing and using site-specific dispersion modeling consistent with the EPA "Guideline on Air Quality Models." To avoid the burden of dispersion modeling, the applicant could use an alternate approach to demonstrate conformance with the ambient levels. Under the alternate approach, the applicant could demonstrate that emissions of metals and HCl, or feed rates

---

1 There is an existing technology-based emission standard for HCl emissions. The purpose of the HCl guidance is to provide a site-specific, risk-based check to ensure that the existing standard is protective. If, however, the existing standard requires a greater level of control than the risk-based standard, the more stringent control applies.

of metals and chlorine, do not exceed emissions or feed rate Screening Limits. The emissions Screening Limits were developed by back-calculating from the RSDs and RACs using dispersion coefficients for reasonable, worst-case facilities. The feed rate Screening Limits were back-calculated from the emissions Screening Limits assuming that all metals and chlorine fed to the device were emitted (i.e., no partitioning to bottom ash or removal by air pollution control equipment).

EPA emphasizes that permit writers choosing to include permit provisions based on this guidance must accept and respond to critical comment with an open mind, just as the Agency has solicited public comment on the proposed approach with an open mind. In addition, permit writers must justify in the administrative record supporting the permit any decisions based on the guidance. The administrative record to the proposed amendments to the incinerator rules presents the basis for the proposed controls. Key parts of this record are attached as Appendix I to this guidance document, and could serve to justify the permit writer's use of the guidance. The key point, however, is that in using the guidance permit writers must keep an open mind, accepting and responding to comment, and justifying use of this guidance, or parts thereof, on the record, just as the Agency will respond to comment on its proposed rules and ultimately any final rule.

Overview of Guidance

Through rulemaking, EPA is developing a tiered series of standards based entirely upon evaluations of health risk. Though they differ in design, each of the tiers meets a common objective. That objective is to limit potential exposure of the most exposed individual to carcinogenic and noncarcinogenic metals and HCl to acceptable additional risks, namely:

- That exposure to all carcinogenic metals of concern be limited such that the sum of the excess risks attributable to ambient concentrations of these metals not exceed an additional lifetime individual risk to the potential most exposed individual (MEI) of 10^{-5}; and
- That exposure to each noncarcinogenic metal and HCl be limited such that exposure to the potential MEI does not exceed the reference air concentration (RAC). For lead, the RAC is 10 percent of the National

> Ambient Air Quality Standard. For HCl, the RAC is 100 percent of the inhalation reference dose (RfD). For the other noncarcinogens, the RACs are 25 percent of the oral RfD converted, 1 to 1, to an inhalation RfD.

Appendix I presents supporting information about health risks for carcinogens and noncarcinogens.

Using air dispersion modeling for 25 reasonable, worst-case incinerators located in complex and noncomplex terrain, and for 11 hypothetical incinerators (representing the range of release parameters for hazardous waste incinerators) assumed to be located at each of these 25 facilities, the Agency is proposing national performance standards for feed rates and emissions limits through a tiered approach. Tier I would set limits on feed rates. The feed rate limits would be back-calculated from the Tier II emission limits assuming no credit for partitioning of metals to bottom ash or for removal of metals or HCl from stack gases by air pollution control devices (APCDs). Thus, the Tier I feed rate limits and the Tier II emission limits would be numerically equal but expressed in different units: lb/hr feed rate versus g/sec emission rate. Compliance with Tier I could be demonstrated simply by analysis of waste feeds. Tier II would set emissions limits derived by back-calculating from ambient levels posing acceptable health risks using dispersion coefficients for reasonable, worst-case facilities. Compliance must be demonstrated by stack emissions tests; thus, partitioning to bottom ash and APCD removal efficiency would be considered. Tier III would allow the applicant to demonstrate by site-specific dispersion modeling that emissions higher than the Tier II limits will nonetheless not result in an exceedance of ambient levels that pose unacceptable health risks. In effect, the applicant would be demonstrating that dispersion of emissions from the facility being permitted is better than for the reasonable, worst-case facilities used to derive the Tier II limits.

In evaluating dispersion coefficients for maximum annual average ground level concentrations for the reasonable, worst-case facilities, EPA has initially determined that terrain and land use classifications[1] have a significant enough effect on dispersion coefficients to establish different Tier I and Tier II screening limits for the following terrain and land use categories:

---

1 *See Appendix I for definitions.*

For Metals

A. Noncomplex terrain (i.e., flat or rolling)

1. Urban land use

2. Rural land use

B. Complex terrain

For HCl

A. Noncomplex terrain

B. Complex terrain

Authority

Section 3005(c)(3) of the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA), provides authority to EPA to establish permit conditions for hazardous waste facilities beyond the scope of existing regulations. It states, "[e]ach permit...shall contain such terms and conditions as the Administrator or State determines necessary to protect human health and the environment." This language has been added verbatim to EPA's hazardous waste regulations at 40 CFR 270.32 by the Codification Rule published at 50 FR 28701-28755 on July 15, 1985.[1] It is also listed as a self-implementing HSWA provision at 40 CFR 271.1(j) in 51 FR 22712-23 (September 22, 1986).

Because this guidance is implemented under HSWA's omnibus authority, it may be put into effect immediately in all States, regardless of their authorization status. EPA has authority to implement this guidance in authorized States until those States have revised their own requirements and such revisions have been approved by EPA. This must occur on or before July 1, 1989. (This assumes that the amendments to 40 CFR 264 Subpart O to control metal emissions will be promulgated in August 1988. The schedule for revising State requirements is given in 40 CFR 271.21(6)(2), as revised at 51 FR 33722.)

1 The preamble to this regulation provides EPA's legal interpretation and discusses its impact on State authorization 950 FR 28728-33).

At present, EPA does not have the authority to reopen existing permits to implement this metals emission guidance.

Structure of This Document

A risk-based approach to permitting can be relatively complex, but every effort has been made to break up the necessary analyses into a series of simple steps.

This guidance document is divided into two principal parts: (1) a structured working document containing step-by-step guidance, and (2) a series of appendices describing the technical basis for the methods and assumptions used. The working document itself is divided into four separately-labeled tabs. Each tab contains all the material necessary to complete the analysis specified. The series of steps needed to conduct the analysis generally is as follows:

Tab A Data Gathering, Terrain Analysis, and Applicability of Screening Tables — The permit writer requests specific data from the applicant to determine the incinerator location (especially its surrounding terrain), relevant factors affecting the dispersion of pollutants from the incinerator (its physical stack height and related information), and requested feed rates by feed system. Using this information, the permit writer determines whether the Tiers I and II Screening Tables will be appropriate for the specific facility in question.[1]

Tab B Determine Feed Rate or Emission Limits (Tiers I and II)—If the Tier I and Tier II Screening Tables are appropriate, the permit writer uses Tab B. Its purpose is to provide the permit writer with tables to look up feed rate (Tier I) or emission (Tier II) limits for each pollutant based on terrain adjusted effective stack height.

Tab C Site-Specific Modeling and Risk Analysis (Tier III)—If the Tier I and Tier II Screening Tables are not appropriate for the facility, or if the facility's feed rates and emissions exceed the values provided by the Screening Tables, the permit writer determines whether to require the applicant to conduct a site-specific risk analysis or to conduct the modeling (and risk assessment) in house (for metals only). If the modeling is conducted in house for flat terrain, the permit writer uses the Graphical Exposure

1 Although the Tier I and Tier II Screening Tables were derived from dispersion analyses of reasonable, worst-case facilities, the limits may not be fully protective in every situation. A particular facility may, in fact, have poorer dispersion than the reasonable, worst-case facilities used in EPA's analyses.

Modeling System (GEMS). If the modeling is conducted in house for rolling or complex terrains, the permit writer may use a screening model approach when applicable. Appendix V contains a screening procedure that is applicable in the special situations presented in Tab C. In these situations, it may be more advantageous to use the screening model in lieu of site-specific dispersion modeling. The screen provides a fast, easy method for estimating potential maximum ambient air concentrations (i.e., dispersion coefficients). The screening methodology is based on air dispersion modeling conducted in accordance with EPA guidelines. It does not, however, require that air dispersion modeling be performed. Instead, it is a simple step-by-step process involving standardized release parameters and generic look-up tables.

Tab D Determine Necessary Permit Conditions—Using the feed rate and/or emission limits from Tab B (Tiers I and II) or the results of site-specific modeling and risk analysis (or a screening model if applicable) as explained in Tab C (Tier III), the permit writer develops the necessary operating requirements for the incinerator and writes them into the permit.

A detailed list of the steps in this document is presented below.

Overview of the Procedure for Establishing Limits

Tab A: Data Gathering, Terrain Analysis, and Applicability of Screening Tables

Step 1: *Gather source data—(from applicant)*

Step 2. *Determine land use characteristics—(using the Auer method)*

Step 3. *Determine suitability of Tier I and Tier II Screening Tables*

—If suitable: go to Tab B

—If not suitable: go to Tab C

Tab B: Determine Feed Rate or Emission Limits (Tiers I and II)

Step 1: *If there is more than one onsite hazardous waste incinerator stack, determine worst-case stack*

Step 2. *Define terrain*

Step 3. *Determine terrain adjusted effective stack height*

Step 4a: *Determine compliance with Tier I feed rate limits*

—If limits exceeded: go to Tab B Step 4b

—If limits not exceeded: go to Tab D

Step 4b: ***Determine compliance with Tier II emission limits***

—If limits exceeded: go to Tab C

—If limits not exceeded: go to Tab D

Tab C: Site-Specific Modeling and Risk Analysis (Tier III)

Step 1: ***The permit writer determines whether to require the applicant to conduct site-specific dispersion modeling (and risk assessment) or to conduct the modeling (and risk assessment) in house.***

—Applicant conducts the modeling and risk assessment: go to Tab C Step 2

—Modeling and risk assessment conducted in house using GEMS for applications when terrain rise is less than 10 percent of stack height.[1]

—If risk acceptable: go to Tab D

—If risk unacceptable: emissions must be reduced

—Where appropriate, modeling conducted in house using the Appendix V Screen:

—If risk acceptable: go to Tab D

—If risk unacceptable: go to Tab C Step 2

Step 2: ***Applicant must submit the dispersion modeling plan for review by the permit writer with assistance from the Regional Meteorologist or PAT***

---

1 It is expected that these modeling runs will be made without inputting terrain data.

Step 3: *Applicant provides the model results and risk analysis for review by the permit writer with assistance from the Regional Meteorologist or PAT*

Tab D: <u>Determine Necessary Permit Conditions</u>

REFERENCES

USEPA. 1977. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Guidelines for Air Quality Maintenance Planning and Analysis — Volume 10 (Revised) — Procedures for Evaluating Air Quality Impact of New Stationary Sources. Research Triangle Park, N.C., EPA-450/4-77-001.

USEPA. 1986. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Guidelines on Air Quality Models (Revised). Research Triangle Park, N.C., EPA-450/2-78-027R.

Tab A: Data Gathering, Terrain Analysis, and Applicability of Screening Tables

The purpose of Tab A is to obtain all the data necessary to establish, using the Screening Tables provided in Tab B, conservative feed rate or emission limits with minimal effort by the applicant and permit writer. This tab will also provide criteria to determine whether or not the feed rate and emission limits provided in Tab B should be applied to a given facility. If these tables are *in*appropriate, the applicant normally would be required to conduct dispersion modeling in conformance with the EPA "Guidelines on Air Quality Models." In some cases, however, when the Screening Tables are *in*appropriate or for the reasons identified in Tab C, the permit writer may use a screening model (Sullivan and Hlinka, 1988) described in Appendix V to predict dispersion coefficients rather than requiring the applicant to conduct site-specific modeling.

Appendix IV contains worksheets to assist the applicant in providing the permit writer with the information required for the analysis.

Tab A consists of the following four steps:

- **Step 1:** Gather source data—(from applicant)
- **Step 2:** Select urban/rural classifications
- **Step 3:** Determine suitability of Tier I and Tier II Screening Tables
  - — If suitable: go to Tab B
  - — If not suitable: go to Tab C

Step 1: Gather source data (from applicant): The first step is to ensure that the applicant provides the information identified in WORKSHEET 1 (see Appendix IV), and submits U.S. Geologic Survey (USGS) 7.5 minute topographic maps showing the terrain within 5 km of the facility.

(A) This form requests information about the following items:

- Facility geographical location
- Terrain parameters
- Stack parameters
- Dimensions of and distances to nearby buildings from the incinerator unit or units
- Requested metal and chlorine feed rates.

Step 2: Determine land use characteristics (using the Auer method).

(A) Determine land use characteristics within 3 km of the stack using the Auer method provided in Appendix I.

Topographic maps, zoning maps and/or aerial photographs can be used to identify land use types. However, this approach can be time consuming and cumbersome. As an alternative, a simplified procedure is shown in Appendix I, which is consistent with the EPA Guideline on Air Quality Models.

(B) Determine the percentage of urban land use types (as defined in Appendix I) that fall within 3 km of the facility.

A planimeter may be used to trace the boundaries of the urban sections to determine the percentage urban area.

(C) The ratio of the urban area to the area of the 3 km circle multiplied by 100 will be the percentage of land use that is urban.

(D) If the urban land use types are less than or equal to 30 percent urban based on a visual estimate (or 50 percent if based on a planimeter), use the rural tables in Tab B.

If the urban land use types (as defined in Appendix I) are greater than 30 percent (or 50 percent based on planimeter measurements), the most conservative (lower) value between the urban and rural Screening Tables should be used, or the standard Auer land use technique applied (Auer 1978, EPA 1986 Guideline on Air Quality Models).

Step 3: Determine the suitability (subject to comment during the permit proceeding) of Tier I and Tier II Screening Tables: This step is to decide, based on the following criteria, whether or not the facility can be evaluated using the feed rate and emission limit tables.

(A) If any of the following criteria are associated with the application, it is recommended that site-specific modeling (or the screening model) be used in lieu of the Tier I and Tier II Screening Tables presented in Tab B:

- Facility is located in a narrow valley less than 1 km wide.
- Facility has a stack taller than 20 m and is located such that the terrain rises to the physical stack height within 1 km of the facility.
- Facility has a stack taller than 20 m and is located within 5 km of the shoreline of a large body of water (such as an ocean or large lake).
- If the physical stack height of any stack is less than 2.5 times the height of the building identified with that stack on WORKSHEET 1 and the distance from the stack to the closest boundary is within five building heights of the associated building or five projected widths of the associated building, then site specific analysis is required because of potential downwash complications at MEI receptors.

(B) If the Screening Tables are determined to be suitable, confirm this with Regional Meteorologist or PAT, and go to Tab B; if not, go to Tab C.

Tab B: Determine Feed Rates or Emission Limits (Tier I and Tier II)

The purpose of Tab B is to determine if the applicant's proposed feed rates or documented, measured emission rates exceed the values established in the Screening Tables.

The Screening Tables classify facilities in terms of terrain-adjusted effective stack height, terrain characteristics, and urban versus rural land use. Both the effective stack height and the screening feed rates or emission limits are determined simply by reading numbers off of Tier I and Tier II Screening Tables provided in the tab. If the facility has more than one hazardous waste incinerator stack onsite, it is recommended that permit writers choose the most conservative (i.e., worst-case) stack as representative (all pollutants are assumed to be emitted from the worst-case stack).

Tab B consists of the following three recommended steps:

- Step 1: If there is more than one onsite hazardous waste incinerator stack, determine worst-case stack
- Step 2: Define terrain
- Step 3: Determine terrain-adjusted effective stack height
- Step 4a: Compare applicant's proposed feed rates to limits in Tier I Screening Tables
  - — If limits exceeded: go to Tab B Step 4b
  - — The applicant may decide to accept lower limits than those proposed
  - — If limits not exceeded: go to Tab D
- Step 4b: Compare applicant's documented emission rates to limits in Tier II Screening Tables
  - — If limits exceeded: go to Tab C
  - — The applicant may decide to accept lower limits than those proposed
  - — If limits not exceeded: go to Tab D

Step 1: Determine worst-case stack for multiple stack sites.

For sites with a single stack,go directly to Step 2. For facilities with multiple stacks, the following procedure must be considered in identifying the worst case stack.

Apply the following equation to each stack:

$$K = HVT$$

Where:K = An arbitrary parameter accounting for relative influence of physical stack height and plume rise.

H = Stack height (m)

V = Flow rate (m^3/sec)

T = Exhaust temperature (K)).

The stack with the lowest value of K is the worst-case stack.

Step 2: Define terrain: The second step is to determine whether the facility lies in complex or noncomplex (i.e., rolling or flat) terrain.

(A) From the data provided on WORKSHEET 1, compare the maximum terrain rise with the physical stack height. For sites with multiple stacks, use the worst case stack identified in Step 1, Tab B. If the terrain rise, within 5 km, is greater than the physical stack height, the facility is considered to be in complex terrain for the purposes of this analysis.

(B) The determination of terrain should be reviewed by the Regional Meteorologist or PAT.

<u>Step 3:</u> Determine terrain-adjusted effective stack height.

(A) If any stack's physical height is less than the minimum GEP (Good Engineering Practice) stack height, then we recommend that a 4 m stack height be used as the terrain-adjusted stack height and this is defined as the worst case stack for subsequent analyses. If this condition applies go to Tab B Step 4a.

Note: Minimum GEP is defined by the following equation:

$$GEP\ (minimum) = H + 1.5L$$

Where: H = Height of a nearby structure (i.e., the stack's associated building from WORKSHEET 1) measured from ground level elevation at the base of the stack

L = The lesser dimension of the height or projected width of a nearby structure (i.e., the stack's associated building from WORKSHEET 1)

(B) Use the stack gas exit flow rate and temperature to determine the corresponding plume rise value from Table B-1. For sites with multiple stacks, use data for the worst case stack determined in Step 1.

(C) Add the plume rise value to the actual physical stack height to determine the effective stack height.

(D) Subtract the maximum terrain rise within 5 km from this value to determine the terrain-adjusted effective stack height.

If the terrain-adjusted effective stack height minus the maximum terrain is less than 4 meters (or is a negative number), then use 4 meters as the terrain-adjusted effective stack height. The tables have been calculated such that the limits given for the 4 meter stack height are to be conservative for any stack height of 4 meters or less.

Note 1: The ISCLT and ISCST dispersion models were used to develop the screening tables. These models, like most EPA models, contain a term to adjust wind speed as a function of physical release height. Wind speed approaches zero as the height of release approaches zero. This results in the concentration term unrealistically increasing as *release height approaches zero. Since low level structures such as storage tanks, buildings, and miscellaneous equipment, will result in low level mixing, a zero effective release height would not be a realistic treatment for an incinerator release, even those with physical release heights less than 4 meters.*

Note:2: We recommend that the physical stack height used in this exercise to determine the terrain - adjusted effective stack height be no greater than the maximum GEP (Good Engineering Practice) stack height for the facility.

The maximum GEP physical stack height is defined as the greater of 65 meters or H + 1.5L, where,

H = Height of a nearby structure (i.e., the stack's associated building from WORKSHEET 1) measured from ground level elevation at the base of the stack.

L = The lesser dimension of the height or projected width of a nearby structure (i.e., the stack's associated building from WORKSHEET 1).

Step 4a: Determine compliance with Tier I feed rate limits.

Noncarcinogens

(A) Using the following tables, read the Tier I feed rate limit for each pollutant that corresponds to the appropriate terrain-adjusted effective stack height:

- Table B-2 for metals, noncomplex terrain
- Table B-3 for metals, complex terrain.
- Table B-10 for HCl

(B) Compare the applicant's proposed total pollutant feed rates with the Tier I limits determined above for each metal:

- If limits exceeded: go to Tab B Step 4b

  —The applicant may decide to accept lower limits than those proposed instead of going to Tab B Step 4b (Tier II)

- If limits not exceeded: go to Tab D.

Note: The recommended means of making this determination for facilities with multiple onsite stacks is to compare the Tier I limit for each pollutant with the total feed rate for all incinerators (i.e., all feeds are assumed to be fed through the i.e., worst-case stack).

Carcinogens

(A) Using the following tables, read the Tier I feed rate limit for each metal that corresponds to the appropriate terrain -effective stack height:

- Table B-4 for noncomplex terrain
- Table B-5 for complex terrain.

(B) If only one carcinogenic metal is incinerated, compare the applicant's proposed feed rate with the Tier I standard determined above:

- If limits exceeded: go to Tab B Step 4b

  —The applicant may decide to accept lower metals limits than those proposed instead of going to Tab B Step 4b (Tier II)

- If limits not exceeded: go to Tab D.

(C) If multiple carcinogenic metals are incinerated, then the sum of the ratios of the proposed total feed rates (actual feed rate) by metal, to the feed rate limits must not exceed 1.0. The following equation would be used:

$$\sum_{i=1}^{n} \frac{\text{Actual Feed Rate}_i}{\text{Tier I Feed Rate Limit}_i} \leq 1.0$$

Where i = carcinogenic metals considered.

If the above equation is > 1.0, then the limits are exceeded

- If limits exceeded: go to Tab B Step 4b

  —The applicant may decide to accept lower metals limits than those proposed instead of going to Tab B Step 4b (Tier II)

- If limits not exceeded: go to Tab D.

Note: For facilities with multiple onsite stacks, it is recommended that permit writers compare the Tier I limit for each metal with the total feed rate for all incinerators (i.e., all feeds are assumed to be fed through the worst-case stack).

Step 4b: Determine compliance with Tier II emission limits.

Noncarcinogens

(A) Using the following tables, read the Tier II emission limit for each pollutant that corresponds to the appropriate terrain-adjusted effective stack height:

- Table B-6 for metals, noncomplex terrain
- Table B-7 for metals, complex terrain.
- Table B-11 for HCl

(B) Compare the actual emission rates with the Tier II limits determined above:

- If limits exceeded: go to Tab C

  —The applicant may decide to accept lower limits than those proposed instead of going to Tab C and performing site-specific modeling

- If limits not exceeded: go to Tab D.

Note: For facilities with multiple onsite stacks, it is recommended that the permit writer compare the Tier II limit for each pollutant with the total emission rate for all incinerators (i.e., all emissions are assumed to be emitted from the worst-case stack).

Carcinogens

(A) Using the following tables, read the Tier II emission limit for each metal that corresponds to the appropriate terrain-adjusted effective stack height:

- Table B-8 for noncomplex terrain
- Table B-9 for complex terrain.

(B) If only one carcinogenic metal is incinerated, compare the actual emission rate with the Tier II standard determined above:

- If limits exceeded: go to Tab C

  —The applicant may decide to accept lower metals limits than those proposed instead of going to Tab C and performing site-specific modeling

- If limits not exceeded: go to Tab D.

(C) If multiple carcinogenic metals are incinerated, then the sum of the ratios of the actual emission rates to the emission limits must not exceed 1.0. The following equation would be used:

$$\sum_{i=1}^{n} \frac{\text{Actual Emissions}_i}{\text{Tier II Emission Limit}_i} \leq 1.0$$

Where i = carcinogenic metals considered.

If the above equation is > 1.0, then the limits are

exceeded:

- If limits exceeded: go to Tab C

  —The applicant may decide to accept lower metals limits than those proposed instead of going to Tab C and performing site-specific modeling

- If limits not exceeded: go to Tab D.

Note: For facilities with multiple onsite stacks, it is recommended that the permit writer compare the Tier II limit for each pollutant with the total emission rate for all incinerators (i.e., all emissions would be assumed to be emitted from the worst-case stack).

The information in the following tables was derived from risk assessments of reasonable worst-case scenarios. Technical background information is included in Appendix I.

Table B-1
Plume Rise Values (m) vs. Stack Parameters

Flow rate* (m3/sec)	Exhaust temperature (K) <325	325-349	350-399	400-449	450-499	500-599	600-699	700-799	800-999	1000-1499	>1499
<0.5	0	0	0	1	1	1	1	1	1	1	1
0.5-0.9	1	1	1	1	1	1	2	2	2	3	2
1.0-1.9	1	1	1	2	2	2	3	3	3	4	4
2.0-2.9	1	1	2	3	4	4	5	5	6	6	7
3.0-3.9	2	2	3	4	5	6	7	7	8	8	9
4.0-4.9	2	2	3	5	6	7	8	9	10	10	11
5.0-7.4	3	3	4	6	7	8	10	11	11	12	13
7.5-9.9	3	4	5	8	10	11	13	14	15	17	18
10.0-12.4	4	5	7	10	12	14	16	18	19	21	23
12.5-14.9	5	5	8	12	14	16	19	21	22	24	27
15.0-19.9	6	6	9	13	16	19	22	24	26	28	31
20.0-24.9	7	8	11	17	20	23	27	30	32	35	38
25.0-29.9	8	9	13	20	24	27	32	35	38	41	44
30.0-34.9	9	10	15	22	27	31	37	40	42	45	49
35.0-39.9	10	12	17	25	31	35	41	44	46	50	54
40.0-49.9	11	13	19	28	34	39	44	48	50	54	58
50.0-59.9	14	15	22	33	40	44	50	55	57	61	66
60.0-69.9	16	18	26	38	45	50	56	61	64	68	74
>69.9	18	20	29	42	49	54	62	67	70	75	81

(1) Using the given stack exit flow rate and gas temperature, find the corresponding plume rise value from the above table.

(2) Add the physical stack height to the corresponding plume rise values [effective stack height = physical stack height + plume rise].

*Plume rise is a function of buoyancy and momentum which are in turn functions of flow rate, not simply exit velocity. Flow Rate is defined as the inner cross-sectional area of the stack multiplied by the exit velocity of the stack gases.

Table B-2
Feed Rate Screening Limits for Noncarcinogenic Metals for Facilities in Noncomplex Terrain

	Values for urban areas					
Terrain-adjusted effective stack height	Antimony (lb/hr)	Barium (lb/hr)	Lead (lb/hr)	Mercury (lb/hr)	Silver (lb/hr)	Thallium (lb/hr)
4m	1.3E-01	2.2E+01	4.0E-02	1.3E-01	1.3E+00	1.3E-01
6m	1.5E-01	2.5E+01	4.5E-02	1.5E-01	1.5E+00	1.5E-01
8m	1.7E-01	2.8E+01	5.1E-02	1.7E-01	1.7E+00	1.7E-01
10m	1.9E-01	3.2E+01	5.8E-02	1.9E-01	1.9E+00	1.9E-01
12m	2.2E-01	3.6E+01	6.5E-02	2.2E-01	2.2E+00	2.2E-01
14m	2.4E-01	4.1E+01	7.3E-02	2.4E-01	2.4E+00	2.4E-01
16m	2.8E-01	4.6E+01	8.3E-02	2.8E-01	2.8E+00	2.8E-01
18m	3.1E-01	5.2E+01	9.4E-02	3.1E-01	3.1E+00	3.1E-01
20m	3.5E-01	5.9E+01	1.1E-01	3.5E-01	3.5E+00	3.5E-01
22m	4.0E-01	6.6E+01	1.2E-01	4.0E-01	4.0E+00	4.0E-01
24m	4.5E-01	7.5E+01	1.4E-01	4.5E-01	4.5E+00	4.5E-01
26m	5.1E-01	8.5E+01	1.5E-01	5.1E-01	5.1E+00	5.1E-01
28m	5.7E-01	9.6E+01	1.7E-01	5.7E-01	5.7E+00	5.7E-01
30m	6.5E-01	1.1E+02	1.9E-01	6.5E-01	6.5E+00	6.5E-01
35m	8.3E-01	1.4E+02	2.5E-01	8.3E-01	8.3E+00	8.3E-01
40m	1.1E+00	1.8E+02	3.2E-01	1.1E+00	1.1E+01	1.1E+00
45m	1.4E+00	2.3E+02	4.1E-01	1.3E+00	1.4E+01	1.4E+00
50m	1.7E+00	2.9E+02	5.2E-01	1.7E+00	1.7E+01	1.7E+00
55m	2.2E+00	3.6E+02	6.5E-01	2.2E+00	2.2E+01	2.2E+00
60m	2.7E+00	4.5E+02	8.0E-01	2.7E+00	2.7E+01	2.7E+00
65m	3.3E+00	5.5E+02	9.9E-01	3.3E+00	3.3E+01	3.3E+00
70m	3.7E+00	6.2E+02	1.1E+00	3.7E+00	3.7E+01	3.7E+00
75m	4.2E+00	7.0E+02	1.3E+00	4.2E+00	4.2E+01	4.2E+00
80m	4.8E+00	8.0E+02	1.4E+00	4.8E+00	4.8E+01	4.8E+00
85m	5.4E+00	9.1E+02	1.6E+00	5.4E+00	5.4E+01	5.4E+00
90m	6.2E+00	1.0E+03	1.9E+00	6.2E+00	6.2E+01	6.2E+00
95m	7.0E+00	1.2E+03	2.1E+00	7.0E+00	7.0E+01	7.0E+00
100m	8.0E+00	1.3E+03	2.4E+00	7.9E+00	8.0E+01	8.0E+00
105m	9.0E+00	1.5E+03	2.7E+00	9.0E+00	9.0E+01	9.0E+00
110m	1.0E+01	1.7E+03	3.1E+00	1.0E+01	1.0E+02	1.0E+01
115m	1.2E+01	1.9E+03	3.5E+00	1.2E+01	1.2E+02	1.2E+01
120m	1.3E+01	2.2E+03	4.0E+00	1.3E+01	1.3E+02	1.3E+01

Table B-2 (Cont.)
Feed Rate Screening Limits for Noncarcinogenic Metals for Facilities in Noncomplex Terrain

	Values for rural areas					
Terrain-adjusted effective stack height	Antimony (lb/hr)	Barium (lb/hr)	Lead (lb/hr)	Mercury (lb/hr)	Silver (lb/hr)	Thallium (lb/hr)
4m	6.9E-02	1.1E+01	2.1E-02	6.9E-02	6.9E-01	6.9E-02
6m	7.9E-02	1.3E+01	2.4E-02	7.9E-02	7.9E-01	7.9E-02
8m	9.0E-02	1.5E+01	2.7E-02	9.0E-02	9.0E-01	9.0E-02
10m	1.0E-01	1.7E+01	3.1E-02	1.0E-01	1.0E+00	1.0E-01
12m	1.3E-01	2.1E+01	3.8E-02	1.3E-01	1.3E+00	1.3E-01
14m	1.5E-01	2.6E+01	4.6E-02	1.5E-01	1.5E+00	1.5E-01
16m	1.9E-01	3.2E+01	5.7E-02	1.9E-01	1.9E+00	1.9E-01
18m	2.4E-01	4.0E+01	7.1E-02	2.4E-01	2.4E+00	2.4E-01
20m	2.9E-01	4.9E+01	8.8E-02	2.9E-01	2.9E+00	2.9E-01
22m	3.8E-01	6.3E+01	1.1E-01	3.7E-01	3.8E+00	3.8E-01
24m	4.8E-01	8.0E+01	1.4E-01	4.8E-01	4.8E+00	4.8E-01
26m	6.1E-01	1.0E+02	1.8E-01	6.1E-01	6.1E+00	6.1E-01
28m	7.7E-01	1.3E+02	2.3E-01	7.7E-01	7.7E+00	7.7E-01
30m	9.8E-01	1.6E+02	2.9E-01	9.8E-01	9.8E+00	9.8E-01
35m	1.6E+00	2.6E+02	4.7E-01	1.6E+00	1.6E+01	1.6E+00
40m	2.4E+00	4.0E+02	7.1E-01	2.4E+00	2.4E+01	2.4E+00
45m	3.3E+00	5.5E+02	9.9E-01	3.3E+00	3.3E+01	3.3E+00
50m	4.4E+00	7.3E+02	1.3E+00	4.4E+00	4.4E+01	4.4E+00
55m	5.8E+00	9.6E+02	1.7E+00	5.8E+00	5.8E+01	5.8E+00
60m	7.6E+00	1.3E+03	2.3E+00	7.6E+00	7.6E+01	7.6E+00
65m	1.0E+01	1.7E+03	3.0E+00	1.0E+01	1.0E+02	1.0E+01
70m	1.2E+01	2.0E+03	3.6E+00	1.2E+01	1.2E+02	1.2E+01
75m	1.4E+01	2.4E+03	4.3E+00	1.4E+01	1.4E+02	1.4E+01
80m	1.7E+01	2.8E+03	5.1E+00	1.7E+01	1.7E+02	1.7E+01
85m	2.0E+01	3.4E+03	6.1E+00	2.0E+01	2.0E+02	2.0E+01
90m	2.4E+01	4.0E+03	7.2E+00	2.4E+01	2.4E+02	2.4E+01
95m	2.9E+01	4.8E+03	8.6E+00	2.9E+01	2.9E+02	2.9E+01
100m	3.4E+01	5.7E+03	1.0E+01	3.4E+01	3.4E+02	3.4E+01
105m	4.1E+01	6.8E+03	1.2E+01	4.1E+01	4.1E+02	4.1E+01
110m	4.8E+01	8.1E+03	1.5E+01	4.8E+01	4.8E+02	4.8E+01
115m	5.8E+01	9.6E+03	1.7E+01	5.8E+01	5.8E+02	5.8E+01
120m	6.9E+01	1.1E+04	2.1E+01	6.9E+01	6.9E+02	6.9E+01

Table B-3
Feed Rate Screening Limits for Noncarcinogenic Metals for Facilities in Complex Terrain

	Values for use in urban and rural areas					
Terrain-adjusted effective stack height	Antimony (lb/hr)	Barium (lb/hr)	Lead (lb/hr)	Mercury (lb/hr)	Silver (lb/hr)	Thallium (lb/hr)
4m	3.1E-02	5.2E+00	9.4E-03	3.1E-02	3.1E-01	3.1E-02
6m	4.6E-02	7.7E+00	1.4E-02	4.6E-02	4.6E-01	4.6E-02
8m	6.7E-02	1.1E+01	2.0E-02	6.7E-02	6.7E-01	6.7E-02
10m	9.9E-02	1.7E+01	3.0E-02	9.9E-02	9.9E-01	9.9E-02
12m	1.2E-01	2.0E+01	3.6E-02	1.2E-01	1.2E+00	1.2E-01
14m	1.5E-01	2.5E+01	4.4E-02	1.5E-01	1.5E+00	1.5E-01
16m	1.7E-01	2.9E+01	5.2E-02	1.7E-01	1.7E+00	1.7E-01
18m	1.9E-01	3.2E+01	5.7E-02	1.9E-01	1.9E+00	1.9E-01
20m	2.1E-01	3.5E+01	6.3E-02	2.1E-01	2.1E+00	2.1E-01
22m	2.3E-01	3.9E+01	7.0E-02	2.3E-01	2.3E+00	2.3E-01
24m	2.6E-01	4.3E+01	7.7E-02	2.6E-01	2.6E+00	2.6E-01
26m	2.9E-01	4.8E+01	8.6E-02	2.9E-01	2.9E+00	2.9E-01
28m	3.2E-01	5.3E+01	9.5E-02	3.2E-01	3.2E+00	3.2E-01
30m	3.5E-01	5.8E+01	1.0E-01	3.5E-01	3.5E+00	3.5E-01
35m	4.4E-01	7.3E+01	1.3E-01	4.3E-01	4.4E+00	4.4E-01
40m	5.4E-01	8.9E+01	1.6E-01	5.4E-01	5.4E+00	5.4E-01
45m	6.6E-01	1.1E+02	2.0E-01	6.6E-01	6.6E+00	6.6E-01
50m	8.1E-01	1.4E+02	2.4E-01	8.1E-01	8.1E+00	8.1E-01
55m	1.0E+00	1.7E+02	3.0E-01	1.0E+00	1.0E+01	1.0E+00
60m	1.2E+00	2.1E+02	3.7E-01	1.2E+00	1.2E+01	1.2E+00
65m	1.5E+00	2.5E+02	4.6E-01	1.5E+00	1.5E+01	1.5E+00
70m	1.7E+00	2.8E+02	5.1E-01	1.7E+00	1.7E+01	1.7E+00
75m	1.9E+00	3.2E+02	5.7E-01	1.9E+00	1.9E+01	1.9E+00
80m	2.1E+00	3.6E+02	6.4E-01	2.1E+00	2.1E+01	2.1E+00
85m	2.4E+00	4.0E+02	7.2E-01	2.4E+00	2.4E+01	2.4E+00
90m	2.7E+00	4.5E+02	8.0E-01	2.7E+00	2.7E+01	2.7E+00
95m	3.0E+00	5.0E+02	9.0E-01	3.0E+00	3.0E+01	3.0E+00
100m	3.4E+00	5.6E+02	1.0E+00	3.4E+00	3.4E+01	3.4E+00
105m	3.8E+00	6.3E+02	1.1E+00	3.8E+00	3.8E+01	3.8E+00
110m	4.2E+00	7.0E+02	1.3E+00	4.2E+00	4.2E+01	4.2E+00
115m	4.7E+00	7.9E+02	1.4E+00	4.7E+00	4.7E+01	4.7E+00
120m	5.3E+00	8.8E+02	1.6E+00	5.3E+00	5.3E+01	5.3E+00

Table B-4
Feed Rate Screening Limits for Carcinogenic Metals for Facilities in Noncomplex Terrain

	Values for use in urban areas				Values for use in rural areas			
Terrain-adjusted effective stack height	Arsenic (lb/hr)	Cadmium (lb/hr)	Chromium (lb/hr)	Beryllium (lb/hr)	Arsenic (lb/hr)	Cadmium (lb/hr)	Chromium (lb/hr)	Beryllium (lb/hr)
4m	1.0E-03	2.5E-03	3.7E-04	1.9E-03	5.3E-04	1.3E-03	1.9E-04	9.5E-04
6m	1.2E-03	2.8E-03	4.2E-04	2.1E-03	6.1E-04	1.5E-03	2.2E-04	1.1E-03
8m	1.3E-03	3.2E-03	4.7E-04	2.4E-03	7.0E-04	1.7E-03	2.5E-04	1.3E-03
10m	1.5E-03	3.6E-03	5.3E-04	2.7E-03	8.0E-04	1.9E-03	2.9E-04	1.4E-03
12m	1.7E-03	4.0E-03	6.0E-04	3.0E-03	9.8E-04	2.3E-03	3.5E-04	1.8E-03
14m	1.9E-03	4.5E-03	6.8E-04	3.4E-03	1.2E-03	2.9E-03	4.3E-04	2.1E-03
16m	2.1E-03	5.1E-03	7.7E-04	3.8E-03	1.5E-03	3.5E-03	5.3E-04	2.6E-03
18m	2.4E-03	5.8E-03	8.7E-04	4.3E-03	1.8E-03	4.4E-03	6.6E-04	3.3E-03
20m	2.7E-03	6.5E-03	9.8E-04	4.9E-03	2.3E-03	5.5E-03	8.2E-04	4.1E-03
22m	3.1E-03	7.4E-03	1.1E-03	5.5E-03	2.9E-03	6.9E-03	1.0E-03	5.2E-03
24m	3.5E-03	8.3E-03	1.3E-03	6.3E-03	3.7E-03	8.8E-03	1.3E-03	6.6E-03
26m	3.9E-03	9.4E-03	1.4E-03	7.1E-03	4.7E-03	1.1E-02	1.7E-03	8.4E-03
28m	4.5E-03	1.1E-02	1.6E-03	8.0E-03	6.0E-03	1.4E-02	2.1E-03	1.1E-02
30m	5.0E-03	1.2E-02	1.8E-03	9.0E-03	7.6E-03	1.8E-02	2.7E-03	1.4E-02
35m	6.5E-03	1.5E-02	2.3E-03	1.2E-02	1.2E-02	2.9E-02	4.3E-03	2.2E-02
40m	8.2E-03	2.0E-02	2.9E-03	1.5E-02	1.8E-02	4.4E-02	6.6E-03	3.3E-02
45m	1.0E-02	2.5E-02	3.8E-03	1.9E-02	2.6E-02	6.1E-02	9.2E-03	4.6E-02
50m	1.3E-02	3.2E-02	4.8E-03	2.4E-02	3.4E-02	8.1E-02	1.2E-02	6.1E-02
55m	1.7E-02	4.0E-02	6.1E-03	3.0E-02	4.5E-02	1.1E-01	1.6E-02	8.0E-02
60m	2.1E-02	5.0E-02	7.4E-03	3.7E-02	5.9E-02	1.4E-01	2.1E-02	1.1E-01
65m	2.5E-02	6.1E-02	9.1E-03	4.6E-02	7.8E-02	1.9E-01	2.8E-02	1.4E-01
70m	2.9E-02	6.9E-02	1.0E-02	5.2E-02	9.3E-02	2.2E-01	3.3E-02	1.7E-01
75m	3.3E-02	7.8E-02	1.2E-02	5.9E-02	1.1E-01	2.6E-01	4.0E-02	2.0E-01
80m	3.7E-02	8.9E-02	1.3E-02	6.7E-02	1.3E-01	3.1E-01	4.7E-02	2.4E-01
85m	4.2E-02	1.0E-01	1.5E-02	7.6E-02	1.6E-01	3.7E-01	5.6E-02	2.8E-01
90m	4.8E-02	1.1E-01	1.7E-02	8.6E-02	1.9E-01	4.5E-01	6.7E-02	3.3E-01
95m	5.4E-02	1.3E-01	1.9E-02	9.7E-02	2.2E-01	5.3E-01	8.0E-02	4.0E-01
100m	6.2E-02	1.5E-01	2.2E-02	1.1E-01	2.6E-01	6.3E-01	9.5E-02	4.7E-01
105m	7.0E-02	1.7E-01	2.5E-02	1.3E-01	3.2E-01	7.5E-01	1.1E-01	5.6E-01
110m	7.9E-02	1.9E-01	2.8E-02	1.4E-01	3.7E-01	9.0E-01	1.3E-01	6.7E-01
115m	9.0E-02	2.2E-01	3.2E-02	1.6E-01	4.5E-01	1.1E+00	1.6E-01	8.0E-01
120m	1.0E-01	2.4E-01	3.7E-02	1.8E-01	5.3E-01	1.3E+00	1.9E-01	9.5E-01

Table B-5
Feed Rate Screening Limits for Carcinogenic Metals for Facilities in Complex Terrain

	Values for urban and rural areas			
Terrain-adjusted effective stack height	Arsenic (lb/hr)	Cadmium (lb/hr)	Chromium (lb/hr)	Beryllium (lb/hr)
4m	2.4E-04	5.8E-04	8.7E-05	4.4E-04
6m	3.6E-04	8.5E-04	1.3E-04	6.4E-04
8m	5.2E-04	1.2E-03	1.9E-04	9.4E-04
10m	7.7E-04	1.8E-03	2.8E-04	1.4E-03
12m	9.4E-04	2.2E-03	3.4E-04	1.7E-03
14m	1.1E-03	2.7E-03	4.1E-04	2.1E-03
16m	1.3E-03	3.2E-03	4.8E-04	2.4E-03
18m	1.5E-03	3.5E-03	5.3E-04	2.6E-03
20m	1.6E-03	3.9E-03	5.9E-04	2.9E-03
22m	1.8E-03	4.3E-03	6.5E-04	3.2E-03
24m	2.0E-03	4.8E-03	7.2E-04	3.6E-03
26m	2.2E-03	5.3E-03	7.9E-04	4.0E-03
28m	2.5E-03	5.9E-03	8.8E-04	4.4E-03
30m	2.7E-03	6.5E-03	9.7E-04	4.9E-03
35m	3.4E-03	8.1E-03	1.2E-03	6.0E-03
40m	4.2E-03	9.9E-03	1.5E-03	7.4E-03
45m	5.1E-03	1.2E-02	1.8E-03	9.2E-03
50m	6.3E-03	1.5E-02	2.3E-03	1.1E-02
55m	7.8E-03	1.9E-02	2.8E-03	1.4E-02
60m	9.6E-03	2.3E-02	3.4E-03	1.7E-02
65m	1.2E-02	2.8E-02	4.2E-03	2.1E-02
70m	1.3E-02	3.2E-02	4.7E-03	2.4E-02
75m	1.5E-02	3.5E-02	5.3E-03	2.7E-02
80m	1.7E-02	4.0E-02	5.9E-03	3.0E-02
85m	1.9E-02	4.4E-02	6.7E-03	3.3E-02
90m	2.1E-02	5.0E-02	7.4E-03	3.7E-02
95m	2.3E-02	5.6E-02	8.3E-03	4.2E-02
100m	2.6E-02	6.2E-02	9.3E-03	4.7E-02
105m	2.9E-02	7.0E-02	1.0E-02	5.2E-02
110m	3.3E-02	7.8E-02	1.2E-02	5.9E-02
115m	3.7E-02	8.7E-02	1.3E-02	6.5E-02
120m	4.1E-02	9.8E-02	1.5E-02	7.3E-02

Table B-6
Emissions Screening Limits for Noncarcinogenic Metals for Facilities in Noncomplex Terrain

	Values for urban areas					
Terrain-adjusted effective stack height	Antimony (g/sec)	Barium (g/sec)	Lead (g/sec)	Mercury (g/sec)	Silver (g/sec)	Thallium (g/sec)
4m	1.7E-02	2.8E+00	5.1E-03	1.7E-02	1.7E-01	1.7E-02
6m	1.9E-02	3.2E+00	5.7E-03	1.9E-02	1.9E-01	1.9E-02
8m	2.1E-02	3.6E+00	6.4E-03	2.1E-02	2.1E-01	2.1E-02
10m	2.4E-02	4.0E+00	7.3E-03	2.4E-02	2.4E-01	2.4E-02
12m	2.7E-02	4.6E+00	8.2E-03	2.7E-02	2.7E-01	2.7E-02
14m	3.1E-02	5.1E+00	9.3E-03	3.1E-02	3.1E-01	3.1E-02
16m	3.5E-02	5.8E+00	1.0E-02	3.5E-02	3.5E-01	3.5E-02
18m	3.9E-02	6.6E+00	1.2E-02	3.9E-02	3.9E-01	3.9E-02
20m	4.4E-02	7.4E+00	1.3E-02	4.4E-02	4.4E-01	4.4E-02
22m	5.0E-02	8.4E+00	1.5E-02	5.0E-02	5.0E-01	5.0E-02
24m	5.7E-02	9.5E+00	1.7E-02	5.7E-02	5.7E-01	5.7E-02
26m	6.4E-02	1.1E+01	1.9E-02	6.4E-02	6.4E-01	6.4E-02
28m	7.2E-02	1.2E+01	2.2E-02	7.2E-02	7.2E-01	7.2E-02
30m	8.2E-02	1.4E+01	2.5E-02	8.2E-02	8.2E-01	8.2E-02
35m	1.1E-01	1.8E+01	3.2E-02	1.1E-01	1.1E+00	1.1E-01
40m	1.3E-01	2.2E+01	4.0E-02	1.3E-01	1.3E+00	1.3E-01
45m	1.7E-01	2.8E+01	5.1E-02	1.7E-01	1.7E+00	1.7E-01
50m	2.2E-01	3.6E+01	6.5E-02	2.2E-01	2.2E+00	2.2E-01
55m	2.7E-01	4.6E+01	8.2E-02	2.7E-01	2.7E+00	2.7E-01
60m	3.4E-01	5.6E+01	1.0E-01	3.4E-01	3.4E+00	3.4E-01
65m	4.1E-01	6.9E+01	1.2E-01	4.1E-01	4.1E+00	4.1E-01
70m	4.7E-01	7.8E+01	1.4E-01	4.7E-01	4.7E+00	4.7E-01
75m	5.3E-01	8.9E+01	1.6E-01	5.3E-01	5.3E+00	5.3E-01
80m	6.0E-01	1.0E+02	1.8E-01	6.0E-01	6.0E+00	6.0E-01
85m	6.9E-01	1.1E+02	2.1E-01	6.9E-01	6.9E+00	6.9E-01
90m	7.8E-01	1.3E+02	2.3E-01	7.8E-01	7.8E+00	7.8E-01
95m	8.8E-01	1.5E+02	2.7E-01	8.8E-01	8.8E+00	8.8E-01
100m	1.0E+00	1.7E+02	3.0E-01	1.0E+00	1.0E+01	1.0E+00
105m	1.1E+00	1.9E+02	3.4E-01	1.1E+00	1.1E+01	1.1E+00
110m	1.3E+00	2.2E+02	3.9E-01	1.3E+00	1.3E+01	1.3E+00
115m	1.5E+00	2.4E+02	4.4E-01	1.5E+00	1.5E+01	1.5E+00
120m	1.7E+00	2.8E+02	5.0E-01	1.7E+00	1.7E+01	1.7E+00

Table B-6 (Cont.)
Emissions Screening Limits for Noncarcinogenic Metals for Facilities in Noncomplex Terrain

	Values for rural areas					
Terrain-adjusted effective stack height	Antimony (g/sec)	Barium (g/sec)	Lead (g/sec)	Mercury (g/sec)	Silver (g/sec)	Thallium (g/sec)
4m	8.7E-03	1.4E+00	2.6E-03	8.7E-03	8.7E-02	8.7E-03
6m	9.9E-03	1.7E+00	3.0E-03	9.9E-03	9.9E-02	9.9E-03
8m	1.1E-02	1.9E+00	3.4E-03	1.1E-02	1.1E-01	1.1E-02
10m	1.3E-02	2.2E+00	3.9E-03	1.3E-02	1.3E-01	1.3E-02
12m	1.6E-02	2.7E+00	4.8E-03	1.6E-02	1.6E-01	1.6E-02
14m	1.9E-02	3.2E+00	5.8E-03	1.9E-02	1.9E-01	1.9E-02
16m	2.4E-02	4.0E+00	7.2E-03	2.4E-02	2.4E-01	2.4E-02
18m	3.0E-02	5.0E+00	9.0E-03	3.0E-02	3.0E-01	3.0E-02
20m	3.7E-02	6.2E+00	1.1E-02	3.7E-02	3.7E-01	3.7E-02
22m	4.7E-02	7.9E+00	1.4E-02	4.7E-02	4.7E-01	4.7E-02
24m	6.0E-02	1.0E+01	1.8E-02	6.0E-02	6.0E-01	6.0E-02
26m	7.7E-02	1.3E+01	2.3E-02	7.7E-02	7.7E-01	7.7E-02
28m	9.7E-02	1.6E+01	2.9E-02	9.7E-02	9.7E-01	9.7E-02
30m	1.2E-01	2.1E+01	3.7E-02	1.2E-01	1.2E+00	1.2E-01
35m	2.0E-01	3.3E+01	5.9E-02	2.0E-01	2.0E+00	2.0E-01
40m	3.0E-01	5.0E+01	9.0E-02	3.0E-01	3.0E+00	3.0E-01
45m	4.2E-01	7.0E+01	1.3E-01	4.2E-01	4.2E+00	4.2E-01
50m	5.5E-01	9.2E+01	1.7E-01	5.5E-01	5.5E+00	5.5E-01
55m	7.3E-01	1.2E+02	2.2E-01	7.3E-01	7.3E+00	7.3E-01
60m	9.6E-01	1.6E+02	2.9E-01	9.6E-01	9.6E+00	9.6E-01
65m	1.3E+00	2.1E+02	3.8E-01	1.3E+00	1.3E+01	1.3E+00
70m	1.5E+00	2.5E+02	4.5E-01	1.5E+00	1.5E+01	1.5E+00
75m	1.8E+00	3.0E+02	5.4E-01	1.8E+00	1.8E+01	1.8E+00
80m	2.1E+00	3.6E+02	6.4E-01	2.1E+00	2.1E+01	2.1E+00
85m	2.6E+00	4.3E+02	7.7E-01	2.6E+00	2.6E+01	2.6E+00
90m	3.0E+00	5.1E+02	9.1E-01	3.0E+00	3.0E+01	3.0E+00
95m	3.6E+00	6.0E+02	1.1E+00	3.6E+00	3.6E+01	3.6E+00
100m	4.3E+00	7.2E+02	1.3E+00	4.3E+00	4.3E+01	4.3E+00
105m	5.1E+00	8.5E+02	1.5E+00	5.1E+00	5.1E+01	5.1E+00
110m	6.1E+00	1.0E+03	1.8E+00	6.1E+00	6.1E+01	6.1E+00
115m	7.3E+00	1.2E+03	2.2E+00	7.3E+00	7.3E+01	7.3E+00
120m	8.6E+00	1.4E+03	2.6E+00	8.6E+00	8.6E+01	8.6E+00

Table B-7
Emissions Screening Limits for Noncarcinogenic Metals for Facilities in Complex Terrain

	Values for use in urban and rural areas					
Terrain-adjusted effective stack height	Antimony (g/sec)	Barium (g/sec)	Lead (g/sec)	Mercury (g/sec)	Silver (g/sec)	Thallium (g/sec)
4m	3.9E-03	6.6E-01	1.2E-03	3.9E-03	3.9E-02	3.9E-03
6m	5.8E-03	9.7E-01	1.7E-03	5.8E-03	5.8E-02	5.8E-03
8m	8.5E-03	1.4E+00	2.6E-03	8.5E-03	8.5E-02	8.5E-03
10m	1.2E-02	2.1E+00	3.7E-03	1.2E-02	1.2E-01	1.2E-02
12m	1.5E-02	2.5E+00	4.6E-03	1.5E-02	1.5E-01	1.5E-02
14m	1.9E-02	3.1E+00	5.6E-03	1.9E-02	1.9E-01	1.9E-02
16m	2.2E-02	3.6E+00	6.5E-03	2.2E-02	2.2E-01	2.2E-02
18m	2.4E-02	4.0E+00	7.2E-03	2.4E-02	2.4E-01	2.4E-02
20m	2.7E-02	4.4E+00	8.0E-03	2.7E-02	2.7E-01	2.7E-02
22m	2.9E-02	4.9E+00	8.8E-03	2.9E-02	2.9E-01	2.9E-02
24m	3.3E-02	5.4E+00	9.8E-03	3.3E-02	3.3E-01	3.3E-02
26m	3.6E-02	6.0E+00	1.1E-02	3.6E-02	3.6E-01	3.6E-02
28m	4.0E-02	6.6E+00	1.2E-02	4.0E-02	4.0E-01	4.0E-02
30m	4.4E-02	7.4E+00	1.3E-02	4.4E-02	4.4E-01	4.4E-02
35m	5.5E-02	9.1E+00	1.6E-02	5.5E-02	5.5E-01	5.5E-02
40m	6.8E-02	1.1E+01	2.0E-02	6.8E-02	6.8E-01	6.8E-02
45m	8.3E-02	1.4E+01	2.5E-02	8.3E-02	8.3E-01	8.3E-02
50m	1.0E-01	1.7E+01	3.1E-02	1.0E-01	1.0E+00	1.0E-01
55m	1.3E-01	2.1E+01	3.8E-02	1.3E-01	1.3E+00	1.3E-01
60m	1.6E-01	2.6E+01	4.7E-02	1.6E-01	1.6E+00	1.6E-01
65m	1.9E-01	3.2E+01	5.8E-02	1.9E-01	1.9E+00	1.9E-01
70m	2.2E-01	3.6E+01	6.5E-02	2.2E-01	2.2E+00	2.2E-01
75m	2.4E-01	4.0E+01	7.2E-02	2.4E-01	2.4E+00	2.4E-01
80m	2.7E-01	4.5E+01	8.1E-02	2.7E-01	2.7E+00	2.7E-01
85m	3.0E-01	5.0E+01	9.1E-02	3.0E-01	3.0E+00	3.0E-01
90m	3.4E-01	5.6E+01	1.0E-01	3.4E-01	3.4E+00	3.4E-01
95m	3.8E-01	6.3E+01	1.1E-01	3.8E-01	3.8E+00	3.8E-01
100m	4.2E-01	7.1E+01	1.3E-01	4.2E-01	4.2E+00	4.2E-01
105m	4.7E-01	7.9E+01	1.4E-01	4.7E-01	4.7E+00	4.7E-01
110m	5.3E-01	8.9E+01	1.6E-01	5.3E-01	5.3E+00	5.3E-01
115m	5.9E-01	9.9E+01	1.8E-01	5.9E-01	5.9E+00	5.9E-01
120m	6.7E-01	1.1E+02	2.0E-01	6.7E-01	6.7E+00	6.7E-01

Table B-8
Emissions Screening Limits for Carcinogenic Metals
for Facilities in Noncomplex Terrain

	Values for use in urban areas				Values for use in rural areas			
Terrain-adjusted effective stack height	Arsenic (g/sec)	Cadmium (g/sec)	Chromium (g/sec)	Beryllium (g/sec)	Arsenic (g/sec)	Cadmium (g/sec)	Chromium (g/sec)	Beryllium (g/sec)
4m	1.3E-04	3.1E-04	4.7E-05	2.3E-04	6.7E-05	1.6E-04	2.4E-05	1.2E-04
6m	1.5E-04	3.5E-04	5.3E-05	2.6E-04	7.7E-05	1.8E-04	2.8E-05	1.4E-04
8m	1.7E-04	4.0E-04	6.0E-05	3.0E-04	8.8E-05	2.1E-04	3.2E-05	1.6E-04
10m	1.9E-04	4.5E-04	6.7E-05	3.4E-04	1.0E-04	2.4E-04	3.6E-05	1.8E-04
12m	2.1E-04	5.1E-04	7.6E-05	3.8E-04	1.2E-04	3.0E-04	4.4E-05	2.2E-04
14m	2.4E-04	5.7E-04	8.6E-05	4.3E-04	1.5E-04	3.6E-04	5.4E-05	2.7E-04
16m	2.7E-04	6.5E-04	9.7E-05	4.8E-04	1.9E-04	4.5E-04	6.7E-05	3.3E-04
18m	3.1E-04	7.3E-04	1.1E-04	5.5E-04	2.3E-04	5.5E-04	8.3E-05	4.2E-04
20m	3.4E-04	8.2E-04	1.2E-04	6.2E-04	2.9E-04	6.9E-04	1.0E-04	5.2E-04
22m	3.9E-04	9.3E-04	1.4E-04	7.0E-04	3.7E-04	8.8E-04	1.3E-04	6.6E-04
24m	4.4E-04	1.1E-03	1.6E-04	7.9E-04	4.7E-04	1.1E-03	1.7E-04	8.4E-04
26m	5.0E-04	1.2E-03	1.8E-04	8.9E-04	5.9E-04	1.4E-03	2.1E-04	1.1E-03
28m	5.6E-04	1.3E-03	2.0E-04	1.0E-03	7.6E-04	1.8E-03	2.7E-04	1.4E-03
30m	6.3E-04	1.5E-03	2.3E-04	1.1E-03	9.6E-04	2.3E-03	3.4E-04	1.7E-03
35m	8.2E-04	1.9E-03	2.9E-04	1.5E-03	1.5E-03	3.6E-03	5.4E-04	2.7E-03
40m	1.0E-03	2.5E-03	3.7E-04	1.9E-03	2.3E-03	5.5E-03	8.3E-04	4.2E-03
45m	1.3E-03	3.2E-03	4.7E-04	2.4E-03	3.2E-03	7.7E-03	1.2E-03	5.8E-03
50m	1.7E-03	4.0E-03	6.1E-04	3.0E-03	4.3E-03	1.0E-02	1.5E-03	7.7E-03
55m	2.1E-03	5.1E-03	7.6E-04	3.8E-03	5.7E-03	1.4E-02	2.0E-03	1.0E-02
60m	2.6E-03	6.2E-03	9.4E-04	4.7E-03	7.5E-03	1.8E-02	2.7E-03	1.3E-02
65m	3.2E-03	7.7E-03	1.2E-03	5.8E-03	9.9E-03	2.4E-02	3.5E-03	1.8E-02
70m	3.6E-03	8.7E-03	1.3E-03	6.5E-03	1.2E-02	2.8E-02	4.2E-03	2.1E-02
75m	4.1E-03	9.9E-03	1.5E-03	7.4E-03	1.4E-02	3.3E-02	5.0E-03	2.5E-02
80m	4.7E-03	1.1E-02	1.7E-03	8.4E-03	1.7E-02	4.0E-02	6.0E-03	3.0E-02
85m	5.3E-03	1.3E-02	1.9E-03	9.5E-03	2.0E-02	4.7E-02	7.1E-03	3.5E-02
90m	6.0E-03	1.4E-02	2.2E-03	1.1E-02	2.4E-02	5.6E-02	8.4E-03	4.2E-02
95m	6.9E-03	1.6E-02	2.5E-03	1.2E-02	2.8E-02	6.7E-02	1.0E-02	5.0E-02
100m	7.8E-03	1.9E-02	2.8E-03	1.4E-02	3.3E-02	8.0E-02	1.2E-02	6.0E-02
105m	8.8E-03	2.1E-02	3.2E-03	1.6E-02	4.0E-02	9.5E-02	1.4E-02	7.1E-02
110m	1.0E-02	2.4E-02	3.6E-03	1.8E-02	4.7E-02	1.1E-01	1.7E-02	8.5E-02
115m	1.1E-02	2.7E-02	4.1E-03	2.0E-02	5.6E-02	1.3E-01	2.0E-02	1.0E-01
120m	1.3E-02	3.1E-02	4.6E-03	2.3E-02	6.7E-02	1.6E-01	2.4E-02	1.2E-01

Table B-9
Emissions Screening Limits for Carcinogenic Metals for Facilities in Complex Terrain

Terrain-adjusted effective stack height	Values for use in urban and rural areas			
	Arsenic (g/sec)	Cadmium (g/sec)	Chromium (g/sec)	Beryllium (g/sec)
4m	3.1E-05	7.3E-05	1.1E-05	5.5E-05
6m	4.5E-05	1.1E-04	1.6E-05	8.1E-05
8m	6.6E-05	1.6E-04	2.4E-05	1.2E-04
10m	9.7E-05	2.3E-04	3.5E-05	1.7E-04
12m	1.2E-04	2.8E-04	4.2E-05	2.1E-04
14m	1.4E-04	3.5E-04	5.2E-05	2.6E-04
16m	1.7E-04	4.0E-04	6.0E-05	3.0E-04
18m	1.9E-04	4.4E-04	6.7E-05	3.3E-04
20m	2.1E-04	4.9E-04	7.4E-05	3.7E-04
22m	2.3E-04	5.4E-04	8.2E-05	4.1E-04
24m	2.5E-04	6.0E-04	9.0E-05	4.5E-04
26m	2.8E-04	6.7E-04	1.0E-04	5.0E-04
28m	3.1E-04	7.4E-04	1.1E-04	5.5E-04
30m	3.4E-04	8.2E-04	1.2E-04	6.1E-04
35m	4.3E-04	1.0E-03	1.5E-04	7.6E-04
40m	5.2E-04	1.3E-03	1.9E-04	9.4E-04
45m	6.5E-04	1.5E-03	2.3E-04	1.2E-03
50m	8.0E-04	1.9E-03	2.9E-04	1.4E-03
55m	9.8E-04	2.3E-03	3.5E-04	1.8E-03
60m	1.2E-03	2.9E-03	4.3E-04	2.2E-03
65m	1.5E-03	3.6E-03	5.3E-04	2.7E-03
70m	1.7E-03	4.0E-03	6.0E-04	3.0E-03
75m	1.9E-03	4.5E-03	6.7E-04	3.3E-03
80m	2.1E-03	5.0E-03	7.5E-04	3.7E-03
85m	2.3E-03	5.6E-03	8.4E-04	4.2E-03
90m	2.6E-03	6.3E-03	9.4E-04	4.7E-03
95m	2.9E-03	7.0E-03	1.1E-03	5.3E-03
100m	3.3E-03	7.8E-03	1.2E-03	5.9E-03
105m	3.7E-03	8.8E-03	1.3E-03	6.6E-03
110m	4.1E-03	9.8E-03	1.5E-03	7.4E-03
115m	4.6E-03	1.1E-02	1.7E-03	8.3E-03
120m	5.2E-03	1.2E-02	1.8E-03	9.2E-03

Table B-10
Tier I Feed Rate Limits for Chlorine

	Noncomplex	Complex
Terrain-adjusted effective stack height	Total Chlorine (lb/hr)	Total Chlorine (lb/hr)
4m	2.0E-01	2.6E-01
6m	2.5E-01	2.7E-01
8m	3.0E-01	2.8E-01
10m	3.7E-01	2.9E-01
12m	4.7E-01	3.3E-01
14m	6.1E-01	3.8E-01
16m	7.8E-01	4.4E-01
18m	9.8E-01	5.0E-01
20m	1.2E+00	5.7E-01
22m	1.6E+00	6.5E-01
24m	2.0E+00	7.4E-01
26m	2.5E+00	8.4E-01
28m	3.1E+00	9.6E-01
30m	3.9E+00	1.1E+00
35m	5.7E+00	1.5E+00
40m	8.0E+00	2.1E+00
45m	1.1E+01	3.0E+00
50m	1.5E+01	4.1E+00
55m	1.9E+01	5.7E+00
60m	2.3E+01	8.0E+00
65m	2.7E+01	1.1E+01
70m	3.0E+01	1.2E+01
75m	3.3E+01	1.3E+01
80m	3.6E+01	1.4E+01
85m	4.0E+01	1.5E+01
90m	4.4E+01	1.7E+01
95m	4.9E+01	1.8E+01
100m	5.4E+01	2.0E+01
105m	5.9E+01	2.1E+01
110m	6.5E+01	2.3E+01
115m	7.2E+01	2.5E+01
120m	7.9E+01	2.7E+01

Table B-11
Tier II Emission Limits for Hydrogen Chloride

Terrain-adjusted effective stack height	Noncomplex HCl (g/sec)	Complex HCl (g/sec)
4m	2.6E-02	3.3E-02
6m	3.1E-02	3.4E-02
8m	3.8E-02	3.5E-02
10m	4.6E-02	3.7E-02
12m	6.0E-02	4.2E-02
14m	7.7E-02	4.8E-02
16m	9.9E-02	5.5E-02
18m	1.2E-01	6.3E-02
20m	1.6E-01	7.2E-02
22m	2.0E-01	8.2E-02
24m	2.5E-01	9.3E-02
26m	3.1E-01	1.1E-01
28m	3.9E-01	1.2E-01
30m	4.9E-01	1.4E-01
35m	7.2E-01	1.9E-01
40m	1.0E+00	2.7E-01
45m	1.4E+00	3.7E-01
50m	1.9E+00	5.2E-01
55m	2.4E+00	7.2E-01
60m	2.9E+00	1.0E+00
65m	3.4E+00	1.4E+00
70m	3.8E+00	1.5E+00
75m	4.2E+00	1.7E+00
80m	4.6E+00	1.8E+00
85m	5.1E+00	1.9E+00
90m	5.6E+00	2.1E+00
95m	6.1E+00	2.3E+00
100m	6.8E+00	2.5E+00
105m	7.5E+00	2.7E+00
110m	8.2E+00	2.9E+00
115m	9.1E+00	3.2E+00
120m	1.0E+01	3.5E+00

Tab C: Site-Specific Modeling and Risk Analysis (Tier III)

Tab C presents methods to determine, under Tier III, if the aggregate cancer risk to the most exposed individual resulting from the metals emissions is less than or equal to 10^{-5}, and if the ambient concentrations of noncarcinogenic metals and HCl are below the reference air concentrations. For some facilities, emission limits under Tier III can be a factor of 10 or more higher than those under Tier II. This is a result of the conservatism built into the Tier II Screening Limits. Within Tier III, the permit writer has the option of (a) performing an in-house dispersion analysis or (b) requiring the applicant to perform detailed site-specific modeling.

If the permit writer performs the dispersion analysis in-house, he has the option of using either the screening procedure which is described in detail in Appendix V or the EPA GEMS model. The Appendix V screening procedure is designed to assist the permit writer to conservatively estimate site-specific hourly and annual average dispersion coefficients. When applicable, the screening procedure provides a more expeditious and less costly alternative to detailed site-specific dispersion modeling. The procedure does not require the permit writer to perform dispersion modeling but is, however, based on extensive dispersion modeling and data processing utilizing the Industrial Source Complex Model (ISCLT). The screening procedure relies primarily on permit data from WORKSHEET 1. Under certain conditions, this procedure reduces the degree of conservatism contained in the Tier I and II tables. The steps shown in Tab C indicate under what conditions this screening procedure is recommended.

The EPA GEMS model is available to permit writers for those situations where the applicant fails using the results of the Appendix V screening procedure. GEMS contains an interactive version of the ISCLT model that will predict dispersion coefficients that are less conservative than those predicted by the screening procedure. Thus higher emission rates and feed rates would be allowed. This option is recommended for situations where the facility is located in flat terrain (i.e., maximum terrain rise from the facility out to 5 km is less than or equal to 10 percent of the physical height of the stack under analysis). GEMS is, however, not useful for short term analyses such as estimating short term risk from HCl emissions. Appendix II presents a description of GEMS and sample model output.

If the use of the Appendix V and GEMS screening procedures are not appropriate, the permit writer may require the applicant to conduct detailed site-specific dispersion modeling. This modeling must conform to the EPA "Guideline on Air Quality Models." WORKSHEET 2 in Appendix V contains a list of the parameters that the applicant must define in order to conduct detailed site-specific modeling analyses.

Tab C consists of the following three steps:

- **Step 1:** The permit writer determines whether to require the applicant to conduct site-specific dispersion modeling and to demonstrate that the established acceptable ambient levels are not exceeded, or to conduct the modeling (and risk assessment) in-house

  — If applicant conducts modeling: go to Tab C Step 2

  — If the permit writer desires to conduct the analyses in house:

  — Use screening procedure (Appendix V), if appropriate, to estimate short-term and long-term dispersion coefficients

  — If the emissions are acceptable on this basis: go to Tab D

  — If the emissions based on the long-term dispersion coefficients generated by the Appendix V screening procedure are unacceptable and the facility is located in flat terrain, use GEMS

  — If HCl emissions based on the short-term dispersion coefficients generated by the Appendix V screening procedure are unacceptable go to Step 2.

  Note:Flat terrain is defined in this report as follows: If the maximum terrain rise within 5 km of the facility is less than 10 percent of the physical stack height of the stack selected for analyses then the location is considered to be flat, and terrain adjustment factors will not be considered.

  — If the GEMS procedure indicates that emissions are unacceptable, then go to Tab C, Step 2

- **Step 2:** Applicant must submit the dispersion modeling plan for review—(by the Regional Meteorologist or PAT)
  - — The applicant must submit information to the Regional Meteorologist or PAT for review. This information includes stack parameters, meteorological data, and terrain data.
- **Step 3:** Applicant provides the model results and risk analysis for review
  - — If emissions are considered acceptable: go to Tab D
  - — If emissions are considered unacceptable: they must be reduced. A new test burn must be conducted to determine whether the (reduced) emissions are acceptable.

Hazardous Waste Incineration Guidance Series

Volume I	Guidance Manual for Hazardous Waste Incinerator Permits, Mitre Corp., 1983.
Volume II	Guidance on Setting Conditions and Reporting Trial Burn Results, Acurex, 1989.
Volume III	Hazardous Waste Incineration Measurement Guidance Manual, MRI, 1989.
Volume IV	Guidance on Metals and Hydrogen Chloride Controls for Hazardous Waste Incineration, Versar Inc., December 1988.
Volume V	Guidance on PIC Controls for Hazardous Waste Incinerators, MRI, April 1989.
Volume VI	Proposed Methods for Measurements of CO, O_2, HCl, and Metals at Hazardous Waste Incinerators, MRI, Late 1989.

Acknowledgements

This guidance was completed by Versar Inc. as partial fulfillment of Contract Number 68-01-7053. The principal authors are Michael Alford, Kevin Jameson, Josefina Castellanos, David Sullivan (Sullivan Environmental Consulting, Inc.), Dennis Hlinka, and Renaldo Jenkins. Major contributions were made by Dwight Hlustick, Mary Cunningham, Robert Holloway, and the Incinerator Permit Writer's Workgroups, including Betty Willis, Y. J. Kim, and Sonya Stelmack. We appreciate the review and guidance of the Monitoring and Data Analysis Division in the Office of Air Quality Planning and Standards in the air dispersion modeling aspects of this document.

DRAFT
FINAL REPORT

GUIDANCE ON METALS AND HYDROGEN CHLORIDE CONTROLS FOR HAZARDOUS WASTE INCINERATORS

Volume IV of Hazardous Waste Incineration Guidance Series

U.S. Environmental Protection Agency
Office of Solid Waste
Waste Treatment Branch
401 M Street, S.W.
Washington, DC 20460
Work Assignment Manager: Dwight Hlustick

August 1989

Step 1: The permit writer determines whether to require the applicant to conduct site-specific dispersion modeling and demonstrate that the established acceptable ambient levels are not exceeded, or to conduct the modeling (and risk assessment) in house).

The following equations are used to determine whether or not the risk levels have been exceeded. For noncarcinogenic metals and HCl, the following equation applies:

$$\frac{\text{MEI Dispersion Coefficient } (\mu g/m^3/g/s) \times \text{Emission } (g/s)}{\text{RAC } (\mu g/m^3)} \leq 1.0$$

Note: For purposes of this guidance the MEI is the offsite, potential MEI unless people reside inside the property boundary of the facility. In this case, the MEI is the potential MEI regardless of whether the point lies within the property boundary.

For carcinogens, the following equations apply:

$$\text{Estimated MEI Risk} = \text{MEI Dispersion Coeff } (\mu g/m^3/g/s) \times \text{Emiss } (g/s) \times \text{Unit Risk } (m^3/\mu g)$$

$$\sum_{i=1}^{n} \frac{\text{Estimated Risk}_i}{1.0 \times 10^{-5}} \leq 1.0$$

Where i = carcinogenic metal considered.

If the applicant conducts the modeling: go to Tab C Step 2

If the permit writer desires to conduct the analysis in-house:

(A) The Regional Meteorologist or the PAT determine whether or not the Appendix V screening procedure is appropriate.

This screening procedure is not appropriate for the following specific conditions:

- Locations within narrow valleys (≤ 1 km in width)
- For stacks ≥ 20 m, locations within 5 km of a shoreline of a major body of water
- Releases from stacks ≤ minimum GEP stack height, where the property boundary is within 5 building heights or 5 maximum projected building widths of buildings creating non-GEP condition

Additionally, the Appendix V screening procedure should not be used if, in the judgment of the PAT or Regional Meteorologist, site-specific factors may result in the screening procedure being unconservative (i.e., underestimating risks).

In many circumstances, the Appendix V screening procedure is more restrictive than Tier I and II limits. However, under the following conditions the screening procedure may be less restrictive than Tier I and II.

- The facility has multiple stacks with substantially different release specifications (e.g., stack heights differ by >50%, exit temperatures differ by > 50 K, or exit flow rates differ by more than a factor of 2)
- The terrain does not reach physical stack height within 1 km of the incinerator, when the stack is greater than 20 m high and in complex terrain
- There is no representative meteorological data available for the site under consideration

- The distance to the nearest facility boundary is greater than the distance shown in the table below for land use type and the effective height of the stack under consideration

Terrain-Adjusted Effective Stack Height Range (meters)	Distance (meters)	
	Urban	Rural
1 to 9.9	200	200
10 to 14.9	200	250
15 to 19.9	200	250
20 to 24.9	200	350
25 to 30.9	200	450
31 to 41.9	200	550
42 to 52.9	250	800
53 to 64.9	300	1000
65 to 112.9	400	1200
113+	700	2500

Note: Options to comply with the emissions limits may include upgrading the APCD(s) or raising the stack to reflect good engineering practice (GEP). It should be noted, however, that EPA is considering a proposal to reduce the particulate standard for hazardous waste incinerators. Thus, in selecting an approach to reduce metals emissions, the applicant should consider that a more stringent particulate standard (e.g., 0.01-0.04 gr/dscf) may be adopted in the future.

- If the Appendix V screening procedure shows emissions to be acceptable: go to Tab D.
- If the screening procedure shows HCl emissions to be acceptable, but metal emissions unacceptable, the permit writer has the option of using GEMS [Tab C Step 1 (B)] or requiring the applicant to do site-specific dispersion modeling [Tab C Step 2].
- If the screening procedure shows HCl emissions to be unacceptable, require the applicant to conduct site-specific dispersion modeling (Tab C Step 2).

(B) Permit writer runs GEMS

- Confirm data on Worksheet 1 that maximum terrain rise out to 5 km is ≤ 10 percent of physical stack height.
- Determine whether metals emissions are acceptable using the equations provided in Tab C Step 1.

  —If exceeded: Emissions must be reduced. A new test burn must be conducted to determine whether the (reduced) emissions are acceptable.

  —If not exceeded: Go to Tab D.

Step 2: Applicant must submit the dispersion modeling plan for review by the Regional Meteorologist or PAT.

(A) The applicant needs to draft a dispersion modeling plan for a site-specific analysis consistent with the EPA "Guideline on Air Quality Models."

(B) The following documentation should be provided with the draft modeling plan:

- The rationale for the selection of the meteorological monitoring station, including a map showing alternative stations considered in the region
- A site layout map showing the locations of all sources and building dimensions for adjacent structures.

(C) The applicant must include a discussion on how a follow-up run will be used to perform a more refined analysis around the area of maximum offsite concentrations. In addition, special receptors should be used to define the distance to the fenceline for each wind direction sector if the initial model runs show that the maximum impacts occur within the first kilometer from the source.

(D) If the closest property boundary is within 5 building heights[1] or 5 times the maximum projected building width[2] of any stack less than GEP, the applicant must include a description of how MEI impacts will be estimated within the cavity zone of the applicable building(s).

(E) The permit writer sends the draft modeling plan and supporting documentation to the Regional Meteorologist or PAT for review. The applicant must revise the modeling plan based on recommendations of the Regional Meteorologist or PAT.

---

1 Refers to building causing non-GEP conditions.

<u>Step 3</u>: Applicant provides the model results and risk analysis for review (See WORKSHEET 2 in Appendix IV).

(A) The model output should include a full printout of the input data, or the full input file should be appended to the results.

(B) The model output is then sent to the Regional Meteorologist or PAT for review to assure that they conform to the modeling plan.

(C) If the Regional Meteorologist or PAT confirms that the model results are valid, then the risk assessment may be used to determine the permit conditions

- If risk is considered acceptable: go to Tab D
- If risk is considered unacceptable: emissions must be reduced.

See the note on the possibility of more stringent particulate standards under Tab C Step 1, A.

Tab D: Determine Necessary Permit Conditions

The purpose of Tab D is to outline permit conditions necessary to control metals and HCl emissions for facilities whose trial burn emissions, in the permit writer's judgment, have passed the risk analysis. If an incinerator fails the risk analysis, a permit should not be awarded until and unless the applicant proves by a new trial burn that the emissions have been reduced sufficiently to pass the risk analysis.

To demonstrate compliance with the emission limits provided by Tier II or that emission will not result in unacceptable ambient levels under Tier III, the applicant must conduct a test burn to determine feed rates and emission rates of metals and HCl. If, however, the trial burn has already been run (or the trial burn plan has already been approved), the permit writer may not want to delay issuance of the permit (or the trial burn) until a test burn can be conducted to determine feed rates and emission rates of metals under trial burn conditions. In this situation, the permit writer should consider establishing interim, conservative feed rate limits for metals. A procedure for establishing interim limits is described below. The interim limits would apply until a test burn is conducted to confirm that the interim feed rate limits result in acceptable emissions. The test burn should be conducted as soon as practicable, certainly within 12 months of establishing the interim limits. Given that the interim limits are designed to be reasonable but conservative, the test burn is likely to demonstrate that higher feed rates will not result in unacceptable emissions.

To establish the interim feed rate limits, the permit writer should back-calculate from an acceptable emission limit using reasonable but conservative assumptions regarding: (1) the removal efficiency of the emission control device (see Appendix III, Table III-8); and (2) partitioning of metals to bottom ash (see Appendix III, Table III-9). Of course, if the permit writer has information that may indicate that the removal efficiency or partitioning values presented in Appendix III may not be conservative in a particular situation, he should use more restrictive values.

Finally, the permit writer must keep in mind the need to provide due process to the applicant and interested parties when establishing the interim limits. The permit writer must explain the rationale for the limits, provide the time and opportunity for comment, fully respond to these comments, and include the responses in the administrative record of the permit.

Step 1: Determine necessary permit conditions: Permit conditions must ensure that emissions over the life of the permit are not greater than those used to demonstrate acceptable risk.

(A) Tier I Permit Conditions

The feed rate limits from Tab B, Step 1 will be specified as permit conditions.

(B) Tier II and Tier III Permit Conditions

The actual feed rates by feed system and the actual emissions determined in the trial burn will be specified as permit conditions.

Note 1: In lieu of limiting feed rates by feed system where many feed systems are used, the feed rate of metals should be specified separately for (1) solid wastes (i.e., nonpumpable wastes); and (2) liquid wastes. In addition, separate limits on each organometal should be established.

These limits are needed because the physical form of the waste (and whether the metal is present as an organic species) has a substantial effect on partitioning to ash versus the stack gas.

Note 2: For Tiers II and III, when more than one combination of waste streams is expected to be burned, a separate trial burn is recommended for each combination, and separate permit conditions will be written for each one.

(C) Additional Permit Conditions

Air pollution control device operation and maintenance requirements should be written into the permit to ensure that the emissions limits are not exceeded.

Waste analysis requirements should also be written into the permit to verify waste composition and, therefore, ensure that the feed rate limits are being met. The frequency of analysis should be specified at the discretion of the permit writer, but should be often enough to quantify any variability in the waste streams.

Appendix III also presents background information on APCD operation and maintenance.

Appendix I. Technical Support for the Modeling and Risk Assessment

Table of Contents

Page No

Appendix I: Technical Support for the Modeling and Risk Assessment

1. Background Information on the Dispersion Modeling Used to Establish Emission Limits I-1

   1.1 Overview of the Modeling Approach I-1
      1.1.1 General Assumptions and Methods. I-1
      1.1.2 Specific Steps of the Analysis I-3

   1.2 Facility Selection I-4

   1.3 Model Selection I-4

   1.4 Input Parameters I-5
      1.4.1 Terrain Analysis I-5
      1.4.2 Release Specifications I-5
      1.4.3 Results and Analysis I-6

2. Urban/Rural Classification Auer Method I-8

   1.2 Simplified Land Use Process I-8

3. Background Information on the Health Risk Assumptions Used to Establish Emission Limits I-12

   3.1 Carcinogens I-12

   3.2 Noncarcinogens I-14

1. BACKGROUND INFORMATION ON THE DISPERSION MODELING USED TO ESTABLISH EMISSION LIMITS

1.1 Overview of the Modeling Approach

The objective of the dispersion modeling analysis was to estimate the maximum short-term (hourly) and annual average ambient concentrations from hazardous waste incineration, based on data from the current incinerator population, and assuming a common emission rate of 1.0 g/sec. The analysis considered the range in height and other release specifications, as well as the effect of variability in meteorology and terrain factors, on predicted concentrations.

The analyses addressed the large differences in facility and site characteristics across the existing hazardous waste incinerators in the U.S. The varying types and sizes of incinerators led to widely differing release terms, i.e., physical stack height, inner stack diameter, exit velocity, and exhaust temperature. Differences in these terms can result in order of magnitude differences in predicted concentrations. Similarly, dispersion and transport of pollutants can be critically affected by terrain and urban/rural land use classification. Thus, the modeling analysis considered the combined effect of release terms, terrain, and urban/rural land use in predicting ambient impacts.

1.1.1 General Assumptions and Methods

The key assumptions and methods used in the modeling analyses are consistent with the EPA "Guideline on Air Quality Models" and with recommendations provided by the modeling staff of the Office of Air Quality Planning and Standards. The approach used here was designed to model a wide range of facilities. In addition to 24 actual incineration facilities, 11 generic hypothetical incinerators representing the range of release parameters for hazardous waste incinerators were modeled, assuming they were located at each of the 24 sites. The modeling approach was designed to:

- Use the most comprehensive data available to characterize existing incinerators. The Regulatory Impact Assessment (RIA) Mail Survey was used as the basis for characterizing current incinerators. Although it is the most comprehensive data set available, there have been closures and modifications to some of these incinerators since 1981 when the survey was taken. The survey provides the location (latitude/longitude) and release specifications for 152 facilities.

- Select sites to represent three types of terrain—flat, rolling, and complex — The modeling was subdivided into three terrain types to show the influence of terrain on the actual and generic release terms evaluated in the modeling analyses. Initially, all of the facilities in the RIA Mail Survey were placed into one of these terrain categories based on broad-scale topographic maps. Those facilities with the lowest effective release heights were selected for detailed analysis. U.S. Geographic Survey topographic maps were then used to make the final determinations among the terrain classifications. Thus, 24 specific facilities were selected on this basis.[1]

For purposes of this guidance, if the terrain rise within 5 kilometers of the stack is less than or equal to 10 percent of the physical stack height, the facility is considered to be in flat terrain. If the terrain rise is greater than 10 percent but less than or equal to the physical stack height, the facility is in rolling terrain. If the maximum terrain rise is greater than the physical stack height, the facility is in complex terrain.

- Assign site-specific urban/rural classifications — Dispersion models can generally be run in an urban or rural mode. The differences in results can be substantial, with the magnitude of these differences being highly dependent on effective release height. To classify the urban/rural status of each site, topographic maps were used to assess land use out to a 3-kilometer radius from each facility, based on a simplified[2] Auer classification (Auer 1978) (See Section 2). The land use approach of the Auer technique was then used as the basis for selection between the urban or rural classification.

- Use site-specific meteorological data — For each of the selected facilities, the available meteorological data from the National Climatic Center were reviewed to identify the most representative meteorological data set for each facility to be modeled. Five-year data sets of hourly surface meteorological data, and twice per day mixing height values, were acquired to support the modeling objectives.

- Model hypothetical incinerators as well as actual incinerators — As previously discussed, 11 generic incinerator sizes were identified for inclusion in all model runs. These generic sources were modeled at every facility, in addition to the actual incinerator present. The results were output individually such that differences in predicted impacts could be assessed.

The need for the generic release terms (hypothetical incinerators) is clear — the scope of modeling over 152 incinerators based on detailed terrain analysis and 5-year hourly meteorological data sets would be too resource intensive. By modeling the generic sources in each of the 24 specific modeling analyses, the effects of the entire range of release parameters on ambient levels could be predicted.

The generic release terms were selected by grouping all incinerators in the RIA Mail Survey by physical stack height. The 25th percentile value for each remaining release specification (inner stack diameter, exit velocity, and exhaust temperature) was then identified for each grouping. The results were smoothed across the groups to obtain the 11 sets of release terms used

---

1 A 25th site (Everett, Washington) was subsequently added.

2 An approach similar to that shown in Appendix I was used. All areas with housing omission tint (pink) on topographic maps were modeled as urban.

in the modeling analyses, i.e., one set of release terms for 10 groups of incinerators.[3]

- Use appropriate models — A wide range of dispersion models can be used to evaluate emissions from combustion sources. The five models selected to meet the objectives of this task are suitable to address the urban and rural sites located in flat, rolling, or complex terrain. Refer to Section 1.3 for a more detailed description of model selection.

1.1.2 Specific Steps of the Analysis

The key steps of the modeling analyses are summarized as follows:

Step 1: Identified candidate facilities from the RIA Mail Survey

Facilities that would most likely have the highest dispersion coefficients (µg/m^3 per g/s) in each terrain category were identified based on (low) effective stack height.

Step 2: Formulated data to support additional sites

Release specifications were compiled for the full set of incinerators in the RIA Mail Survey. These data were needed to select the most appropriate generic source for those facilities that were not specifically modeled.

Step 3: Compiled generic release specifications

Eleven release terms were identified to represent groups of incinerators from the RIA Mail Survey.

Step 4: Modeled actual and generic release specifications

Each of the models was executed consistent with standard EPA modeling practices, and the results were quality controlled.

Step 5: Developed dispersion coefficient vs. effective stack height categories

Dispersion coefficients for metals as a function of effective stack height were analyzed by terrain type and land use classification to identify categories where dispersion coefficients were significantly different. Those categories were:

---

3 One generic source was also added to conservatively represent low-level stacks that have pollutants rapidly transported to the surface by building-induced turbulence. This generic source was not, however, included in the Tier I or II tables because the 4 m stack was selected to represent downwash cases.

- Flat and rolling terrain (noncomplex)

  —urban land use

  —rural land use

- Complex terrain.

Dispersion coefficients for HCl as a function of effective stack height were also analyzed by terrain type and land use classification to identify categories where dispersion coefficients were significantly different. Unlike for metals, dispersion coefficients for urban/rural scenarios did not differ significantly. The land use categories identified were:

- Flat and rolling terrain (noncomplex)

- Complex terrain.

1.2 Facility Selection

Nine facilities in complex terrain, and 8 each in the noncomplex terrain categories (flat, rolling) were selected for detailed modeling. Once the topographic data were compiled, the terrain classifications of certain sites were modified.

1.3 Model Selection

The actual incinerator release specifications for each facility and terrain data were used to select the appropriate model. Once selected, the actual release specifications and a set of generic release modifications ranging from release heights of 5 to 100 meters were evaluated during each modeling analysis. Based on the EPA "Guideline on Air Quality Models" and input from the EPA Office of Air Quality, Planning and Standards, the following models were selected:

Terrain classification	Urban/Rural	Averaging period	Model selected
Flat or Rolling	Urban or Rural	Annual Average	ISCLT
Flat or Rolling	Urban or Rural	Hourly	ISCST
Complex	Urban	Annual Average	LONGZ
Complex	Urban	Hourly	SHORTZ
Complex	Rural	Hourly or Annual	COMPLEX I

- Flat and Rolling Terrain: The Industrial Source Complex models (ISCLT and ISCST) were selected for flat and rolling terrain because they can address building downwash and elevated releases and can account for terrain differences between sources and receptors. The long-term mode (ISCLT) was used for annual averages, while the short-term mode (ISCST) was used to estimate maximum hourly concentrations.

- Complex Terrain: Complex terrain applications required the use, in this case, of three separate models. For urban applications, EPA recommends SHORTZ for short-term averaging periods and LONGZ for seasonal or annual averages. For rural sites located in complex terrain, EPA recommends use of COMPLEX I.

1.4 Input Parameters

1.4.1 Terrain Analysis

U.S. Geological Survey 7.5 minute topographic maps were acquired to document terrain out to 5 kilometers from each facility. Maximum terrain heights were compiled for each of 16 wind directions and distances of 0 to 200 meters, 200 to 500 meters, 500 to 1,000 meters, 1,000 to 1,500 meters, 1,500 to 2,000 meters, 2,000 to 3,000 meters, 3,000 to 4,000 meters, and 4,000 to 5,000 meters.

1.4.2 Release Specifications

1.4.2.1 Actual Incinerators

The release specifications used for each of the actual facilities were acquired through the RIA Mail Survey. There are a large number of hazardous waste incinerators that have stacks of less than 10 meters, and relatively low effective release heights. Each of these releases was modeled as an elevated release, because data were not available on the dimensions and locations of nearby structures. The use of generic release specifications (described in the next subsection), however, provides a release specification to conservatively address low-level stacks affected by building downwash.

1.4.2.2 Generic Release Specifications

The objective of the generic release specifications is to show meteorological and terrain-induced variability across a set of common specifications. In this manner, facilities not among the 24 modeled individually could still be screened. The first step in determining these specifications was to subdivide the RIA Mail Survey into ten categories of incinerators based on ranges of effective stack height. Then, within each stack height category, a single facility was selected whose effective stack height approximated the 25th percentile of the range of effective stack heights in the category. The 25th percentile was chosen because the goal was to conservatively represent the release specifications within each group of incinerators, not to use the most conservative release specification for each group. In addition, an 11th generic release specification was defined in order to represent facilities whose height of releases do not meet good engineering practice (GEP).[4]

The consideration of effective release height is especially important for facilities with high exhaust temperatures. There was no clear pattern for exhaust temperature as a function of release height. While diameter and exit velocity were found to be a function of release height, exhaust temperatures varied widely and did not show a strong function of release height. For the purpose of this modeling analysis, 325 Kelvin (K) was used for all generic release specifications. Actual facilities may have exhaust temperatures much higher than this value.

The use of effective release height is an important element to this approach. Nevertheless, effective release height is a variable that is a function of wind speed and atmospheric stability. In choosing the most effective release type for a specific facility, the approach used a high wind speed (i.e., 6.8 m/sec) and neutral conditions for specific sources as the generic sources. In this manner, a conservative plume rise value could be used to select the most appropriate generic source. This approach allows for the use of specific release specifications in order to select the most representative generic stack, while conservatively addressing the issue of variability of effective release height as a function of wind speed.

1.4.3 Results and Analysis

All input and output files were quality controlled by an independent analyst. There was a wide range of predicted concentrations for metals and HCl across the various release specifications.

The results were plotted on scatter diagrams so that the relationship between dispersion coefficient and effective stack height could be ascertained. In order to ensure that the emission limits are conservative, the outer envelope of the curve (the maximum value for each modeled effective stack height) was used to determine the dispersion coefficient corresponding to those effective stack heights falling between the modeled values. Actual and generic sources were both considered in these scatter diagrams.

---

4 Minimum good engineering practice (GEP) physical stack height is defined as $H_g = H + 1.5L$, where:
Hg = GEP physical stack height measured from ground level elevation at the base of the stack.
H = Height of nearby structure measured from ground level elevation at the base of the stack.
L = The lesser dimension of the height or projected width of a nearby structure.
Source: 40 CFR 51.1 (ii).

The straight line connecting each two modeled points was determined (using a logarithmic relationship). This line was used to generate dispersion coefficients at the intermediate effective stack heights. The effective stack height interval chosen was 2 meters up to 30 meters, then 5 meters up to 120 meters. Beyond 120 meters no data were generated.

The next step was to calculate, based on the conservative dispersion coefficients, the allowable emissions corresponding to the risk limits.

1.4.3.1 Noncarcinogens

For the noncarcinogens, the ambient concentration is calculated by the following equation:

$$\text{Ambient Concentration} = \text{Dispersion Coefficient } (ug/m^3)/(g/sec) \times \text{Emission } (g/sec)$$

This equation is solved for emission, and the RAC (see Section 3.2) is used in place of ambient concentration (because the RAC is the upper limit of allowed concentrations). This equation is solved for each dispersion coefficient (relating to each effective stack height).

1.4.3.2 Carcinogens

For carcinogens, the risk is defined by the following equation:

$$\text{Risk} = \text{Dispersion Coefficient } (ug/m^3/(g/sec) \times \text{Emission } (g/sec) \times \text{Unit Risk } (m^3/ug).$$

This equation is solved for emission, and the upper limit of 1E-5 is used for the risk for each carcinogen. Since the carcinogenic risk limit is the aggregate cancer risk and the emission limits are based on 1E-5 for each metal individually, the allowable carcinogenic metal emissions from all carcinogenic metals are constrained by the following relation:

$$\sum_{i=1}^{n} \frac{\text{Actual Emission}}{\text{Emission Limit}} \leq 1$$

where i = the number of carcinogenic metals.

2. URBAN/RURAL CLASSIFICATION—AUER METHOD

There is a need to classify areas in the vicinity of incineration sites as urban or rural in order to set risk-based emission limits. This classification is needed because dispersion rates differ between urban and rural areas and thus, the risk per unit emission rate differs accordingly. The combination of greater surface roughness (more buildings/structures to generate turbulent mixing) and the greater amount of heat released from the surface in an urban area (generates buoyancy-induced mixing) produces greater rates of dispersion. The emission limit tables in the regulation, therefore, distinguish between urban and rural areas. The following describes the approach to be used in selecting the appropriate urban or rural designation for this rule.

EPA guidance (EPA 1986) shows two alternative procedures to determine whether the character of an area is predominantly urban or rural: (1) land use typing or (2) a method based on population density. Both approaches require consideration of characteristics within a 3-km radius from a source, in this case the incinerator stack(s). The land use method is preferred because it more directly relates to the surface characteristics that affect dispersion rates. The remainder of this discussion is thus, focused on the land use method.

While the land use method is more direct, it also can be labor intensive to apply. For this discussion, we have simplified the land use approach. Our goal is to be consistent with EPA guidance for urban/rural classification (EPA 1986; Auer 1978), while streamlining the process for the majority of applications so that a clear-cut decision can be made without the need for detailed analysis. Table 1 summarizes the recommended simplified approach to classifying areas as urban or rural. As shown, the applicant always has the option of applying standard (i.e., more detailed) analyses to more accurately distinguish between urban or rural areas. The procedure presented here, however, allows for simplified treatments, where appropriate, to expedite the permitting process.

2.1 Simplified Land Use Process

The land use approach considers four primary land use types: industrial (I), commercial (C), residential (R), and agricultural (A). Within these primary classes, subclasses are identified, as shown in Table 1. The goal is to estimate the percentage of the area within a 3-km radius that is urban type and the percentage that is rural type. Industrial and commercial areas are classified as urban; agricultural areas are classified as rural.

Table 1

Classification of Land Use Types

Type[1]	Description	Urban or rural designation[2]
I1	Heavy Industrial	Urban
I2	Light/Moderate Industrial	Urban
C1	Commercial	Urban
R1	Common Residential (Normal Easements)	Rural
R2	Compact Residential (Single Family)	Urban
R3	Compact Residential (Multi-Family)	Urban
R4	Estate Residential (Multi-Acre Plots)	Rural
A1	Metropolitan Natural	Rural
A2	Agricultural	Rural
A3	Undeveloped (Grasses/Weeds)	Rural
A4	Undeveloped (Heavily Wooded)	Rural
A5	Water Surfaces	Rural

1. EPA, Guideline on Air Quality Models (Revised), EPA-450/2-78-027, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, July, 1986.

2. Auer, August H. Jr., "Correlation of Land Use and Cover with Meteorological Anomalies," Journal of Applied Meteorology, pp. 636-643, 1978.

The delineation of urban and rural areas, however, can be more difficult for the residential type areas shown in Table 1. The degree of resolution shown in Table 1 for residential areas often cannot be identified without conducting site area inspections and/or referring to zoning maps. This process can require extensive analysis, which, for many applications, can be greatly streamlined without sacrificing confidence in selecting the appropriate urban or rural classification.

The fundamental simplifying assumption is based on the premise that many applications will have clear-cut urban/rural designations, i.e., most will be in rural settings that can be definitively characterized through a brief review of topographical maps. The color coding on USGS topographical maps provides the most effective means of simplifying the typing scheme. The suggested typing designations for the color codes found on topographical maps are as follows:

Green Wooded areas (rural).

White White areas generally will be treated as rural. This code applies to areas that are unwooded and do not have densely packed structures, which would require the pink code (house omission tint). Parks, industrial areas, and unforested rural land will appear as white on the topographical maps. Of these categories, only the industrial areas could potentially be classified as urban based on EPA 1986 and Auer 1978. Industrial areas can be easily identified in most cases by the characteristics shown in Figure 1. For this simplified procedure, white areas that have an industrial classification will be treated as an urban areas.

Pink Pink areas indicate house omission and will be treated as urban in this simplified procedure.[5] The effect of this simplification is to group housing types R1 and R4 (shown in Table 1) into the urban fraction, thereby removing the need to consider housing types—the most cumbersome step in the standard classification method. Conservative safeguards have been incorporated into the simplified approach to ensure that this simplification does not result in allowable emission rates that exceed the 10^{-5} risk criterion.

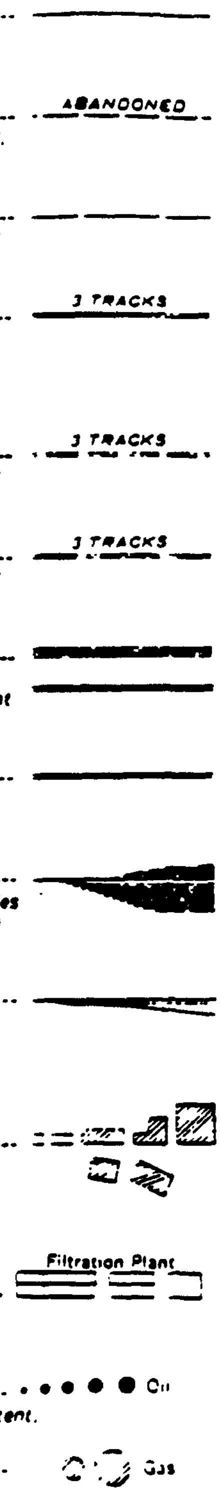
Blue Water areas (rural).

Purple Purple areas indicate revisions to previous topographical maps. If individual residences are visible, treat as rural; otherwise, treat as urban.

5 These areas can be counted within the rural fraction if the vegetation covers 70 percent or more of the area, but for simplicity, these areas will be treated as urban in this procedure.

Figure 1

Supplementary Publication Symbols



117 Single track ....
Line weight .005" Tie weight .003", length .04", spaced .20" center to center.

118 Single track abandoned....................
Same as existing track with space .02", dash .18". Label.

119 Single track under construction......
Same as existing track with space .02", dash .38" Label UNDER CONSTRUCTION.

120 Multiple main line track ....
Overall width .017" Line weight .003". Tie length .052" spaced .20" center to center. If more than two tracks label, with double crosstie at point of change. Double crosstie .017" overall width.

121 Multiple track abandoned ....
Same as existing track with space .02", dash .18" Label ABANDONED.

122 Multiple track under construction ...
Same as existing track with space .02", dash .38" Label UNDER CONSTRUCTION.

123 Juxtaposition ....
Alternate ties, spaced .20" center to center. Minimum space between tracks .011" Line weight for single tracks .005", multiple tracks .003".

124 Railroad in street ....
Ties spaced .20" center to center. Label if narrow gage. Tie weight .003".

125 Yards...
Line weight .003" Space between tracks .011" Ties spaced .20" center to center, maximum length to touch 6 tracks.

126 Sidings ....
Line weight .003". Scribe to scale with minimum space between tracks .011" Ties spaced .20" center to center, length .04" for single track.

176 Large buildings ....
Outline weight .003". When width exceeds .06" hatch at 45° angle to building in NE direction, lines .002" spaced .02" center to center.

178 Sewage disposal or filtration plant_
Line weight .003" See symbol 700 for blue hatching. Label.

196 Tanks: oil, gas, water, etc. ....
Circle .03" minimum .10" maximum Label as to content.

197 Tanks: oil, gas, water, etc. ....
Exceeding .10" diameter Outline weight .003" Hatch SW-NE with .002" lines spaced .02" center to center Label as to content

Based on the color code and review of the 3-km radius shown on the topographical map(s) for the facility under review, the following steps should be performed:

1. Identify all white areas that are characterized by the industrial codes and circle on the maps—label as "urban" (to be counted in the urban fraction).

2. Visually inspect the area within the 3-km radius. If the total of the white areas labeled as "urban" plus the pink areas appears to be less than 30 percent of the total area within the 3-km radius, select the emission rates from the rural tables. If the total urban types appear to be greater than 30 percent, and a planimeter is available, go to step 3; otherwise, proceed directly to step 4.

3. Measure and sum the white areas labeled as "urban" and the pink areas with a planimeter to more accurately estimate the percentage of land areas that is included as urban types. If this percentage is less than 50, use the emission rates from the rural tables. If this area is greater than or equal to 50 percent, go to step 4.

4. Use these final options to classify the site as urban or rural:

    a. Review emissions limits based on the urban <u>and</u> rural tables and select the more restrictive case or

    b. Follow the standard land use methods documented in EPA 1986, and Auer 1978. This removes the conservative assumption that all pink areas (house omission tint) are urban.

3. BACKGROUND INFORMATION ON THE HEALTH RISK ASSUMPTIONS USED TO ESTABLISH EMISSION LIMITS

3.1 Carcinogens

EPA policy suggests that no threshold dose can be demonstrated experimentally for carcinogens. This leads to the assumption that any exposure theoretically represents some finite level of risk. EPA's Carcinogen Assessment Group (CAG) has estimated the carcinogenic potency for humans exposed to low dose levels of carcinogens. The potency factors have been used to estimate the unit risk of carcinogenic constituents lists in 40 CFR Part 60, Appendix A. The unit risk is defined as the incremental risk to an individual exposed for a lifetime to ambient air containing one microgram of the compound per cubic meter of air.

This methodology considers inhalation as the only exposure pathway, and does not take into account indirect exposures such as ingestion or dermal contact. Cancer risk is assumed to result only from exposure to the incinerator emissions. Cancer incidences resulting from other industrial or nonindustrial sources are not considered.

A second issue concerns the methodology, which confines the analysis to the potential most exposed individual (MEI). The potential MEI risk is the risk at the point where the maximum concentration occurs regardless of the actual population distribution. Total population risk, which could be expressed as total potential cases produced by the facility, is not part of the analysis.

The Agency is proposing that, using reasonable worst-case assumptions, an incremental lifetime risk to the MEI of less than 1×10^{-5} (1 cancer case per 100,000 people) is a reasonable acceptable risk. The aggregate risk to the MEI is calculated by predicting the maximum annual average ground level concentration for each carcinogenic emission, calculating the estimated risk from that ambient concentration using the unit risk factor, and summing the risk for all carcinogenic compounds. EPA's Carcinogen Assessment Group (CAG) has estimated carcinogenic potency factors for humans exposed to known and suspected human carcinogens. These factors are the basis for estimating "unit risks" of carcinogens at the low doses associated with typical levels of exposure to airborne carcinogens in the ambient environment. Table I-2 presents the unit risk values for the carcinogens under consideration.

Nickel is not a carcinogen under consideration because the only carcinogenic forms of nickel, nickel carbonyl and nickel subsulfide, are compounds that can be reduced under reducing conditions and, thus, are not believed to be emitted from incineration processes.

Table I-2

Unit Risk Values for Carcinogens

Metal	Unit Risk$(ug/m^3)^{-1}$
Arsenic	4.3E-03
Beryllium	2.4E-03
Cadmium	1.8E-03
Chromium	1.2E-02

3.2 Noncarcinogens

For toxic substances not known to display carcinogenic properties, there appears to be an identifiable exposure threshold below which adverse health effects usually do not occur. Toxic effects are manifested only when these noncarcinogens are present in concentrations above that threshold. Thus, protection against the adverse health effects of a threshold toxicant is likely to be achieved by preventing exposure levels from exceeding the reference dose (RfD).

Reference air concentrations (RACs) have been developed for HCl and those noncarcinogenic metals listed in Appendix VIII of 40 CFR Part 261 for which the Agency has adequate health effects data. The exposure threshold level for lead is 10 percent of the NAAQS. The RAC for HCl is 100 percent of the inhalation RfD. Selenium is not being evaluated because health effects data are not available.

An oral RfD is an estimate of a daily exposure (via ingestion) for the human population that is likely to be without an appreciable risk of deleterious effects even if exposure occurs daily during a lifetime. The RfD for a specific chemical is calculated by dividing the experimentally determined no-observed-adverse-effect-level by the appropriate uncertainty factor(s).

The Agency is proposing to use the following equation to convert oral RfDs to RACs in mg/m^3:

$$RAC = \frac{\text{RfD (mg/kg-bw/day) x body weight x correction factor x background levels}}{m^3 \text{ air breathed/day}}$$

where:

- RfD is the oral reference dose;
- Body weight is assumed to be 70 kg for an adult male;
- Volume of air breathed by an adult male is assumed to be 20 m^3/day;
- Correction factor for route to route extrapolation (going from the oral route to the inhalation route is assumed to be 1.0); and
- Factor to apportion the RfD to the intake resulting from direct inhalation of the compound emitted from the source is 0.25 (i.e., an individual is assumed to be exposed to 75 percent of the RfD from the combination of other sources).

The RACs are used to determine if adverse health effects are likely to result from exposure to stack emissions by comparing ground level concentrations of a pollutant to the pollutant's RAC. If the RAC is not exceeded, adverse health effects are not anticipated.

The Agency's reasoning for proposing RACs derived from oral RfDs is as follows:

1. EPA has developed verified RfDs and is committed to establishing RfDs for all constituents of Agency interest. The verification process is conducted by an EPA work group, and the conclusions and reasoning for these decisions are publicly available.

2. The verification process assures that the critical study is of appropriate length and quality to derive a health limit for long-term, lifetime protection.

3. RfDs are based on the best available information that meets minimal scientific criteria and may come from experimental animal studies or human studies.

4. RfDs are designed to give long-term protection to all members of the population including persons at unusual risk, such as pregnant women, growing children, and older men and women.

5. RfDs are designated by the Agency as being of high, medium, or low confidence depending on the quality of the information and the amount of supporting data.

The Agency used the following strategy to derive the inhalation exposure limits:

1. Where a verified oral RfD has been based on an inhalation study, the inhalation exposure limit will be calculated directly from the study.

2. Where a verified oral RfD has been based on an oral study, a conservative assumption for route to route extrapolation in deriving an inhalation limit will be used; that is, the conversion factor is assumed to be 1.

3. Where EPA health documents containing relevant inhalation toxicity data exist, such as the Health Effects Assessments (HEAs) and the Health Effects and Environmental Profiles (HEEPs), the data will be used in deriving an inhalation exposure limit. Other agency health documents (e.g., NIOSH's criteria documents) will also be considered.

4. The Agency recognizes the limitations of the route-to-route conversions used to derive the RACs and is in the process of examining the confounding factors affecting these conversions such as: (a) the appropriateness of extrapolating when a portal of entry is the critical target organ; (b) first pass effects; and (c) the effect of the route upon dosimetry. The Agency is developing reference dose values for inhalation exposure, and many are expected to be available this year.

Table I-3 presents the reference air concentrations for the noncarcinogens under consideration.

Table I-3

Reference Air Concentrations for Noncarcinogens

Metal	RAC ($\mu g/m^3$)
Antimony	0.3
Barium	50
Lead	0.09
Mercury	0.3
Silver	3
Thallium	0.3
Hydrogen Chloride	150 (3 min)
	7 (annual)

Appendix II. Using the GEMS System

Table of Contents

Page No

Appendix II: Using the GEMS System

Step-by-Step Procedures for Using GEMS
Step 1: Accessing the GEMS System and GAMS Subsystem......II-1
Step 2: Obtain Meteorological Data Requirements for ISCLT......II-1
Step 3: Consult with the Regional Meteorologist or the Permit Assistance Team (PAT)......II-2
Step 4: Identify the Worst-Case Stack......II-2
Step 5: Create the ISCLT Input File and Run the Model......II-3
Step 6: Follow up Model Runs for Greater Detail......II-5

Procedures for Using GEMS

Step 1: Accessing the GEMS system and GAMS subsystem.

(A) Use (or open) an active account on EPA's Vax system. To open a new account, contact Ms. Pat Harrigan ((202) 382-3397) or Mr. Daryl Kaufman ((202) 382-3929).

(B) Use a terminal that prints all input and output information directly onto a printer.

(C) Get into the GEMS system. Enter "YES" to the system prompt.

Refer to the GEMS user's manual included in this appendix.

(D) Answer the prompt to identify your terminal type by entering the appropriate number.

Step 2: Obtain meteorological data requirements for ISCLT: One of the key data requirements for ISCLT is a representative meteorological data set. The GAMS package contains a national data base for meteorological conditions (currently being updated with the latest data from the National Climatic Center). When the user identifies the location of the incinerator (by latitude and longitude), the GEMS software lists the weather stations nearest to the site that can be used in the model run. This list typically contains about five to seven stations.

(A) Enter "2" for Geodata Handling, "2" for Environmental Data Locator, "5" Search for STAR Station.

(B) Enter "1 ISC, 2 LAT/LON." Then type "NEXT."

(C) Using as an example a latitude of 33° 45' 35"N and a longitude of 84° 23' 44", type the following incorporating the actual latitude/longitude values from the incinerator application:

"1 334535, 2 842344." Then type "NEXT."

(D) Enter "GO" when prompted.

(E) The GEMS software will print out the available meteorological stations for the ISCLT model run.

(F) Enter "BACK," then "EXIT," and "YES" to confirm the Exit command. When the "$" prompt appears, enter "LOGOFF" to leave the GEMS system.

Step 3: Consult with the Regional Meteorologist or the Permit Assistance Team (PAT).

(A) Ask for assistance from the Regional Meteorologist or PAT to identify the most representative meteorological station for the incinerator site.

(B) The Regional Meteorologist or PAT should determine whether the source is located in a special terrain feature or near a shoreline that would make the available meteorological data from GEMS inappropriate for modeling the incinerator site.

(C) If the Regional Meteorologist or PAT determines that the meteorological data available through GEMS is *not* appropriate for the site, perform site-specific modeling.

Step 4: Identify the worst-case stack.

(A) If the facility has more than one incinerator stack, use the following equation for each stack:

$$K=HVT$$

Where: K = An arbitrary parameter accounting for relative influence of physical stack height, plume rise, and the total feed rate.

H = Physical stack height (m)

V = Flow rate (m^3/sec)

T = Exhaust temperature (K).

The stack with the lowest value of K is the worst-case stack.

(B) If the facility has only one incinerator stack, then this is the worst-case stack.

Step 5: Create the ISCLT input file and run the model.

(A) Get back into the GEMS system. Enter "YES" to the system prompt.

(B) Answer the prompt to identify your terminal type by entering the appropriate number.

(C) Enter the option numbers "1" for Modeling, "1" for Air Models, "4" for GAMS system, and "1" for GAMS interface.

(D) Enter "AUTOHELP." Then enter "NEW" for new study, then a 1 to 10 character study name (e.g., "FACILITY X"), a 1 to 80 character study title, and a 1 to 6 character run name (e.g., "RUN1").

(E) Enter "ISC" for model to be used, "C" for concentration, a 1 to 60 character chemical name (e.g., "METALS"), and "PARTICLE" for the state of the chemical.

(F) Enter "NO" for chemical removal and "NO" for dry deposition.

(G) Enter a 1 to 24 character site name (e.g., "ATLANTA") and "L" for site location identifier. Enter the latitude of the site (e.g., "33 45 35") and the longitude (e.g., "84 23 44"). After the STAR stations are printed, enter the four-digit station number of the station chosen by the Regional Meteorologist or PAT. Enter "R" if the site is rural or "U1" if the site is urban.

(H) When the site name prompt comes up again, simply hit the return or enter key.

(I) Enter "YES," then "SP" for special grid distances. Enter the following distances for each of the ring prompts: 0.2 (or shortest distance to fenceline if greater than 0.2 kilometer), 0.4, 0.6, 0.8, 1.0, 1.5, 2.0, 3.0, 4.0, and 5.0. For example: the system will prompt with "Enter the last ring distance in kilometers:," to which is entered "0.2" (or the shortest distance to fenceline), etc. When the system prompts for the 11th distance, simply hit the enter or return key.

(J) Enter "1" for the number of concentration points per ring.

(K) Enter a 1 to 24 character source category name (e.g., "INCINERATOR"), then enter a 1 to 12 character name for the first emission type (e.g., "SOURCE1").

(L) Enter "S" for method of treating this emission type. Then enter the corresponding values to the system prompts for exit temperature, exit velocity, and inner stack diameter of the worst-case stack found in Step 4.

(M) If the physical stack height is less than 2.5 times the nearby building height, then enter "YES" to the building wake effects prompt. If the physical stack height is greater than 2.5 times the nearby building height, enter "NO" and skip to step (N). Enter the height and width (the results of taking the square root of the length times width) of the nearby building at the system prompt.

(N) Enter the physical stack height at the system prompt.

(O) Enter the site name used in (G) above (e.g., "ATLANTA"), then enter the source category used in step (K) (e.g., "INCINERATOR"). Next enter "1.0" when the system prompts for the stack emission rate. Simply hit the enter or return key when the system prompts for the source category again.

(P) Enter "YES" to save the ISC model output, then enter a 1 to 40 character title that will be placed on the top of each page of model output (e.g., "ANNUAL CONCENTRATIONS FOR FACILITY X"). Then enter "ALL" to prompt for summary tables.

(Q) Enter "NONE" to the exposure calculations prompt, "NO" to the estimation of lifetime risk, and "YES" to saving the concentration files. The system will respond with "GAMSIN session completed," indicating that the ISCLT input file is created.

(R) Enter "2" for the GAMS model run, then enter the study name used in step (D) at the system prompt. Enter "GO" to run GAMS. The system indicates the job entry number as the model run is started. Within a few minutes the system will indicate that the run is completed.

(S) Enter "EXIT" and "YES" to leave the GAMS system. Enter the run name used in step (D) as in the following example: "TYPE RUNISC001.OUT" and the model results will be printed.

(T) Enter "LOGOFF" to leave the GEMS system.

(U) Review model output.

Step 6: Follow up model runs for greater detail.

Repeat the entire Step 5 process, with the exception of using up to 10 ring distances, equally spaced, between the standard distances shown to have the maximum offsite concentrations. For example, if the maximum was shown to occur between 0.4 and 0.6 km, the follow-up model run would contain ring distances of 0.40, 0.425, 0.45, 0.475 km, and so forth up to 0.60 km.

```
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
*                            G E M S                            *
*---------------------------------------------------------------*
* 1. Two FM/EXPORT procedures G2DBF and G2DBF are now available for *
*    data conversion from GEMS datasets to .DBF and .DIF files. The *
*    .DBF and .DIF files can be downloaded to IBM PC for use in the *
*    dBASE III and LOTUS 1-2-3 software respectively.     (1/12/86) *
* 2. A  VT100 full screen editor is now available for creating and  *
*    modify GEMS datasets.   This editor can be selected from the   *
*    File Management menu.                                (2/12/87) *
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

MENU: Terminal Type Specification

      1. VT100-compatible terminal          2. Tektronix 4010 terminal
      3. VT100 with TEK4010 emulator        4. Tektronix 4014 terminal
      5. 80  column ASCII terminal          6. Tektronix 4105 terminal
      7. 132 column ASCII terminal          8. Tektronix 4106 terminal
      9. LA120 DECwriter terminal          10. Tektronix 4107 terminal

Please identify your terminal type by number
? 7
[?3h)

                    GRAPHICAL EXPOSURE MODELING SYSTEM

                              Version  8.1

                              developed by

                      GENERAL SCIENCES CORPORATION

                                  for

                   U.S. ENVIRONMENTAL PROTECTION AGENCY
                 OFFICE OF PESTICIDES AND TOXIC SUBSTANCES



A series of HELP information is available by entering HELP or TUTOR command.
Use the PR procedure in the Utilities operation to report problems in GEMS.


MENU: Graphical Exposure Modeling System

1.  Modeling                                                      (MO)
2.  Geodata Handling                                              (GH)
3.  Graphics                                                      (GR)
4.  File Management                                               (FM)
5.  Estimation                                                    (ES)
6.  Statistics                                                    (ST)
7.  Utilities                                                     (UT)

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
? 1
```

```
MENU: Modeling

1.  Air Models                                          (AIR)
2.  Soil Models                                         (SOIL)
3.  Water Models                                        (WATER)
4.  Multimedia Models                                   (MULTI)

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
? 1

MENU: Air Models

1.  Single Area Source Box Model                        (BOXMOD)
2.  Point Source (hourly concen.) Model                 (PTDIS)
3.  Point Source (maximum concen.) Model                (PTMAX)
4.  GEMS Atmospheric Modeling Subsystem                 (GAMS)
5.  Gaussian INtegrated PUFF Model                      (INPUFF)

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
? 4

MENU: GEMS Atmospheric Modeling Subsystem

1.  GAMS INterface                                      (GAMSIN)
2.  GAMS model RUN                                      (GAMSRUN)
3.  GAMS UTILities                                      (GAMSUTIL)

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
? 1
```

GAMS

GEMS Atmospheric Modeling Subsystem
Version 1.1

by

GENERAL SCIENCES CORPORATION

```
*-* GAMS CONTROL *-*

Are you setting up a new study or re-entering a study: new

Enter the study name: clute

Enter the study title: plans to list halogen acid furnaces as industrial furnaces

Enter the run name: texas

Which of the atmospheric models will you be using in the study: help


  The atmospheric models currently available are the Industrial
  Source Complex (ISC) long-term model and the atmospheric area
  source model (TOXBOX).  Enter either ISC, TOXBOX, or BOTH.

Which of the atmospheric models will you be using in the study: isc

Are you calculating concentration or total deposition in the ISC model: help


  Type CONCENTRATION (C) if you want to calculate average ground-level
  concentration.  Type DEPOSITION (D) to calculate only total deposition.
  When modeling concentration, plume depletion due to gravitational
  settling can be accounted for.

Are you calculating concentration or total deposition in the ISC model: c


*-* GAMS CHEMICAL DATA *-*

Enter the chemical name: generic

Enter the state of the chemical: help


  Type GAS if the pollutant is gaseous, or type PARTICLE if
  the pollutant is a particulate.

Enter the state of the chemical: particle




              **************************************
              *                                    *
              *   INDUSTRIAL SOURCE COMPLEX MODEL  *
              *                                    *
              **************************************
```

- ISC REMOVAL SPECIFICATIONS *-*

Do you want to include chemical removal in the ISC model: help

Respond YES for plume depletion due to the atmospheric half-life decay term in the ISC model. Respond NO, or press RETURN, for no plume depletion.

Do you want to include chemical removal in the ISC model: n

Do you want to include dry deposition removal in the ISC model: help

Type YES if you want to calculate ground-level concentration with deposition occurring. Type NO, or press RETURN, if you want to calculate concentration without deposition. Gravitational settling generally acts to reduce concentrations. When particle size data are not available or a conservative analysis is desired, gravitational settling should generally be suppressed. However, note that for close-in receptors near high stacks, concentrations can be substantially increased through the use of gravitational settling.

Do you want to include dry deposition removal in the ISC model: n

- ISC SITE LOCATION AND METEOROLOGY *-*

Enter the site name: clute texas

Enter the site location identifier: help

Type LAT/LONG (L) if you want to enter the latitude/longitude coordinates of the site. Type zip code (Z) if you want to have the site centered on the coordinates of the postal zip code which you will enter. Latitude and longitude values are preferable since the use of zip code information only approximates the actual location and may significantly affect estimates of population exposure.

Enter the site location identifier: l

Enter the latitude of the site in degrees minutes seconds: 28 59 7

Enter the longitude of the site in degrees minutes seconds: 95 23 23

INDEX NUMBER	STATION NAME	LAT deg min	LON deg min	PERIOD OF RECORD	STABILITY CLASSES	DISTANCE (km)
0065	GALVESTON/SCHOLES TX	N 29 16 /	W 94 52	1956-1960	6	59.6
0062	HOUSTON/HOBBY 129 TX	N 29 39 /	W 95 17	1964-1968	6	74.6
1182	VICTORIA/FOSTER TX	N 28 51 /	W 96 55	1965-1974	6	149.2
1702	PRT ARTHUR/JEFFER TX	N 29 57 /	W 94 01	1972-1976	6	170.7
0700	BEEVILLE/CHASE TX	N 28 23 /	W 97 40	1965-1969	6	231.8
0068	CORPUS CHRISTI TX	N 27 42 /	W 97 16	1965-1969	6	232.5
0796	LAKE CHARLES LA	N 30 07 /	W 93 13	1966-1970	6	244.7

Enter the STAR station (INDEX) number: 0065

Specify rural or one of the urban modes: help

Type RURAL (R) to specify rural mode, which does not redefine the stability categories. Type URBAN1 (U1) to redefine the E and F stability categories as D. Type URBAN2 (U2) to redefine stability category B as A, C as B, D as C, and E and F as D. It should be noted that the use of URBAN2 generally is not recommended for regulatory purposes.

Specify rural or one of the urban modes: r

Enter the site name: help

The name of the site may consist of up to 24 characters. You may specify up to 100 sites by typing a site name each time it is requested. Press RETURN to signal you are finished.

Enter the site name:

- ISC POLAR COORDINATE GRID SPECIFICATIONS *-*

Do you want to apply the same polar grid at all sites: help

Type YES if you want to apply the same polar coordinate grid at all sites, otherwise type NO (or press RETURN)

Do you want to apply the same polar grid at all sites: y

Enter STANDARD or SPECIAL for the polar coordinate system: help

Type STANDARD (ST) if you want a polar coordinate system consisting of 16 sectors and 10 rings at distances of 0.5, 1, 2, 3, 4, 5, 10, 15, 25, and 50 kilometers, and 3 concentrations for each ring applied at all sites. Type SPECIAL (SP) if you want to specify your own coordinate characteristics.

Enter STANDARD or SPECIAL for the polar coordinate system: st

- ISC SOURCE CHARACTERIZATION *-*

```
Enter the source category name: help


  The source category name may consist of up to 24 characters.
  You may specify up to twenty source categories by typing a
  source category name each time it is requested.  Press
  RETURN to signal you are finished.  Examples of source
  categories are as follows: Manufacturing, Refining, Power
  Generation.  Type LIST to obtain a list of source categories
  entered.

Enter the source category name: plant b

Enter the 1st emission type name: help


  The emission type name may consist of up to 12 characters.
  You may make up to fifty emission type entries per source category
  by typing an emission type name each time it is requested.  You are
  limited to nine unique emission type names per source  category and
  ten unique names across all source categories.  Press RETURN to signal
  you are finished.  Examples of emission types are as follows:  process,
  storage, fugitive process, fugitive erosion.  Type LIST to obtain a list
  of emission types entered.

Enter the 1st emission type name: process

Specify the method of treating this emission type: help


  Type STACK (S) if you want to have the emission treated as a
  stack source, type VOLUME (V) to treat the emission as a volume
  source, or type AREA (AR) if the emission is to be treated as
  an area source.  Point sources are typically treated as stack
  emissions.

Specify the method of treating this emission type: s

Enter the stack gas exit temperature in degrees Kelvin: 300

Enter the stack gas exit velocity in meters per second: 12

Enter the inner stack diameter in meters: 0.9

Do you wish to consider building wake effects: help


  Type YES if you wish to consider wake effects for the current
  emission type, otherwise type NO, or press RETURN.  You will be
  prompted for the height and width of the building adjacent to
  the stack upon a YES response.

Do you wish to consider building wake effects: n
```

Enter the height of the pollutant emission in meters: help

This is the height above ground in meters of the pollutant emission. For volume sources, this is the height to the center of the source.

Enter the height of the pollutant emission in meters: 40

Enter the 2nd emission type name:

Enter the source category name:

- MATCHING ISC SOURCES WITH ISC SITES *-*

Current site: clute texas

Enter a source category for this site: help

Specify a source category that applies to the current site. You may specify more than one by typing a source category each time it is requested. Press RETURN to signal you are finished. Type LIST to obtain a listing of source categories entered.

Enter a source category for this site: plant b

Enter the 1st PROCESS (Stack) emission strength: 1.0

Enter a source category for this site:

- ISC OUTPUT SPECIFICATIONS *-*

Do you wish to save the ISC model output: y

Enter the title for the ISC model output: emissions

Specify the input data to be printed in the ISC model output: help

Type NONE (N) to indicate that no input data are to be printed in the ISC model output file. Type CRM (C) to print the control parameters, receptor and meteorological data. Type SOURCE (S) to print the source input data. Type ALL (AL) to indicate all input data are to be printed in the ISC model output file.

Specify the input data to be printed in the ISC model output: all

```
*-* GAMS POSTPROCESSING SPECIFICATIONS *-*

Which of the exposure calculations do you want to estimate: help


  Type EXPOSURE, INHALATION exposure, BOTH, or NONE.  Responding BOTH will
  give one table of both exposure and inhalation exposure results.  Respond
  NONE for no exposure or inhalation exposure tables.

Which of the exposure calculations do you want to estimate: none

Do you want to estimate excess lifetime risk: help


  Type YES if you want excess lifetime risk estimations.  Type NO,
  or press RETURN, if you do not want risk estimations.

Do you want to estimate excess lifetime risk: n

Do you want to save the concentration files: y

GAMSIN session completed

MENU: GEMS Atmospheric Modeling Subsystem

1.  GAMS INterface                                          (GAMSIN)
2.  GAMS model RUN                                          (GAMSRUN)
3.  GAMS UTILities                                          (GAMSUTIL)

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
? 2

 The studyname you will enter should correspond with a studyname
 from the following list


              =========== GAMS STUDY NAMES ===========
              |                                      |
              |  CHEM        CHEM1       CINDY       |
              |  CLUTE       COMPLEX                 |
              |  TEXAS                               |
              |                                      |
              ========================================


Enter the studyname for this GAMS run: clute
Enter GO to run GAMS: go
Job GAMS (queue SYS$BATCH, entry 1295) started on SYS$BATCH

MENU: GEMS Atmospheric Modeling Subsystem

1.  GAMS INterface                                          (GAMSIN)
2.  GAMS model RUN                                          (GAMSRUN)
3.  GAMS UTILities                                          (GAMSUTIL)

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
?

Job GAMS (queue SYS$BATCH, entry 1295) completed
```

```
exit

Type YES or NO to confirm the EXIT command
? y
$ dir texas*.*;*

Directory DBA2:[EEDVER1]

TEXAS.GRUN;1        TEXAS.LOCK;1          TEXAS.LOG;1         TEXAS.SITES;1
TEXAS.SOURCES;1     TEXAS001.ISC;1        TEXAS01.GAMS;1      TEXASISC001.OUT;1
TEXASISC01.CONC;1   TEXASISCEM1.CONC;1    TEXASTOT.CONC;1

Total of 11 files.
$ type texas001.isc;1
SITE 001 - clute texas              - EMISSIONS
 1 2 2 0 0 3 2 3 3 0 0 0-7-8-9 0 0 1 0 0
   1   0  30  16   0   1   6   6  16   0

    166.67    333.33    500.00    666.67    833.33   1000.00   1333.33   1666.67
   2000.00   2333.33   2666.67   3000.00   3333.33   3666.67   4000.00   4333.33
   4666.67   5000.00   6666.67   8333.33  10000.00  11666.67  13333.33  15000.00
  18333.33  21666.67  25000.00  33333.34  41666.67  50000.00
        0.     22.50
(7x,6f7.5)
    N A 0.000020.000110.000000.000000.000000.00000
  NNE A 0.000010.000070.000000.000000.000000.00000
   NE A 0.000040.000050.000000.000000.000000.00000
  ENE A 0.000010.000070.000000.000000.000000.00000
    E A 0.000030.000160.000000.000000.000000.00000
  ESE A 0.000050.000110.000000.000000.000000.00000
   SE A 0.000030.000180.000000.000000.000000.00000
  SSE A 0.000060.000180.000000.000000.000000.00000
    S A 0.000050.000110.000000.000000.000000.00000
  SSW A 0.000010.000050.000000.000000.000000.00000
   SW A 0.000050.000000.000000.000000.000000.00000
  WSW A 0.000040.000050.000000.000000.000000.00000
    W A 0.000010.000050.000000.000000.000000.00000
  WNW A 0.000010.000050.000000.000000.000000.00000
   NW A 0.000060.000180.000000.000000.000000.00000
  NNW A 0.000040.000050.000000.000000.000000.00000
    N B 0.000490.001440.001350.000000.000000.00000
  NNE B 0.000210.000840.000820.000000.000000.00000
   NE B 0.000320.000570.000500.000000.000000.00000
  ENE B 0.000110.000320.000370.000000.000000.00000
    E B 0.000280.000800.001280.000000.000000.00000
  ESE B 0.000320.001070.001550.000000.000000.00000
   SE B 0.000350.001140.002440.000000.000000.00000
  SSE B 0.000210.000750.001830.000000.000000.00000
    S B 0.000540.001480.003150.000000.000000.00000
  SSW B 0.000290.000410.000660.000000.000000.00000
   SW B 0.000330.000390.000210.000000.000000.00000
  WSW B 0.000040.000230.000090.000000.000000.00000
    W B 0.000370.000570.000320.000000.000000.00000
  WNW B 0.000250.000660.000320.000000.000000.00000
   NW B 0.000190.000430.000300.000000.000000.00000
  NNW B 0.000160.000300.000180.000000.000000.00000
```

```
  N C 0.000250.001370.006600.001320.000160.00000
NNE C 0.000140.000660.004250.000690.000070.00000
 NE C 0.000260.000780.003590.000550.000050.00000
ENE C 0.000120.000430.002100.000660.000140.00000
  E C 0.000120.000890.006940.003110.000250.00002
ESE C 0.000130.001000.009730.004160.000270.00000
 SE C 0.000120.001210.010600.004450.000480.00002
SSE C 0.000170.000800.007740.003680.000340.00000
  S C 0.000290.001280.012700.007860.001100.00002
SSW C 0.000060.000620.003520.003400.001580.00005
 SW C 0.000140.000340.001320.000570.000320.00000
WSW C 0.000090.000370.000940.000110.000000.00000
  W C 0.000170.000410.001300.000160.000000.00005
WNW C 0.000080.000500.001530.000160.000020.00002
 NW C 0.000060.000640.001460.000180.000160.00011
NNW C 0.000060.000550.001350.000230.000110.00005
  N D 0.000450.002310.009550.022490.013610.00525
NNE D 0.000230.001300.008360.017450.010280.00329
 NE D 0.000420.001780.014070.019460.006330.00123
ENE D 0.000260.001370.010250.014590.006370.00121
  E D 0.000460.003010.017490.021630.006100.00130
ESE D 0.000320.003010.022700.033050.006300.00121
 SE D 0.000470.002630.028590.037750.006070.00089
SSE D 0.000180.001260.019570.030150.005410.00048
  S D 0.000580.002100.021810.041110.008500.00037
SSW D 0.000170.000960.006170.017010.004610.00037
 SW D 0.000210.000820.005320.009000.002380.00055
WSW D 0.000140.000370.002310.002470.000660.00011
  W D 0.000250.000660.002560.003360.000910.00030
WNW D 0.000080.000660.003200.004750.002280.00075
 NW D 0.000210.000840.004250.009930.005320.00196
NNW D 0.000090.000460.003150.007670.006420.00386
  N E 0.000000.001940.003450.000000.000000.00000
NNE E 0.000000.000940.002670.000000.000000.00000
 NE E 0.000000.002630.006330.000000.000000.00000
ENE E 0.000000.001780.002670.000000.000000.00000
  E E 0.000000.003520.004860.000000.000000.00000
ESE E 0.000000.003770.009820.000000.000000.00000
 SE E 0.000000.003240.014910.000000.000000.00000
SSE E 0.000000.002080.011760.000000.000000.00000
  S E 0.000000.003560.022970.000000.000000.00000
SSW E 0.000000.001070.009130.000000.000000.00000
 SW E 0.000000.001580.008310.000000.000000.00000
WSW E 0.000000.000890.003170.000000.000000.00000
  W E 0.000000.000780.003770.000000.000000.00000
WNW E 0.000000.000710.002260.000000.000000.00000
 NW E 0.000000.001050.004270.000000.000000.00000
NNW E 0.000000.000480.002120.000000.000000.00000
  N F 0.002330.002740.000000.000000.000000.00000
NNE F 0.001340.001780.000000.000000.000000.00000
 NE F 0.002390.002560.000000.000000.000000.00000
ENE F 0.001370.001990.000000.000000.000000.00000
```

```
  E F 0.003370.003650.000000.000000.000000.00000
ESE F 0.002090.003430.000000.000000.000000.00000
 SE F 0.003040.004840.000000.000000.000000.00000
SSE F 0.001440.003040.000000.000000.000000.00000
  S F 0.003870.006690.000000.000000.000000.00000
SSW F 0.002070.003490.000000.000000.000000.00000
 SW F 0.004200.004750.000000.000000.000000.00000
WSW F 0.002210.002010.000000.000000.000000.00000
  W F 0.001840.002350.000000.000000.000000.00000
WNW F 0.001460.001900.000000.000000.000000.00000
 NW F 0.001490.002670.000000.000000.000000.00000
NNW F 0.000520.000960.000000.000000.000000.00000
   296.70    296.70    296.70    294.00    291.60    291.60
  2017.50
  1345.00
  1345.00
  1345.00
   501.00
   501.00
     0.00
     0.00
     0.00
     0.00
     0.02
    0.035
       0.        0.        0.        0.        0.        0.      0.00
     0.00      0.00      0.00      0.00      0.00      0.00
       0.        0.

     0.07
     0.07
      0.1
0.15000001
0.34999999
0.55000001
01011000       0.00       0.00  40.00    0.00 300.00  12.00    0.9   0.00    0.000 0
     1.00
$ type texasisc001.out;1
```

- ISCLT INPUT DATA -

NUMBER OF SOURCES = 1
NUMBER OF X AXIS GRID SYSTEM POINTS = 30
NUMBER OF Y AXIS GRID SYSTEM POINTS = 16
NUMBER OF SPECIAL POINTS = 0
NUMBER OF SEASONS = 1
NUMBER OF WIND SPEED CLASSES = 6
NUMBER OF STABILITY CLASSES = 6
NUMBER OF WIND DIRECTION CLASSES = 16
FILE NUMBER OF DATA FILE USED FOR REPORTS = 1
THE PROGRAM IS RUN IN RURAL MODE
CONCENTRATION (DEPOSITION) UNITS CONVERSION FACTOR =0.10000000E+07
ACCELERATION OF GRAVITY (METERS/SEC**2) = 9.800
HEIGHT OF MEASUREMENT OF WIND SPEED (METERS) = 10.000
ENTRAINMENT PARAMETER FOR UNSTABLE CONDITIONS = 0.600
ENTRAINMENT PARAMETER FOR STABLE CONDITIONS = 0.600
CORRECTION ANGLE FOR GRID SYSTEM VERSUS DIRECTION DATA NORTH (DEGREES) = 0.000
DECAY COEFFICIENT =0.00000000E+00
PROGRAM OPTION SWITCHES = 1, 2, 2, 0, 0, 3, 2, 3, 3, 0, 0, 0, 7,-8,-9, 0, 0, 1, 0, 0,
ALL SOURCES ARE USED TO FORM SOURCE COMBINATION 1

RANGE X AXIS GRID SYSTEM POINTS (METERS)= 166.67, 333.33, 500.00, 666.67, 833.33, 1000.00,
1333.33, 1666.67, 2000.00, 2333.33, 2666.67, 3000.00, 3333.33, 3666.67, 4000.00, 4333.33,
4666.67, 5000.00, 6666.67, 8333.33, 10000.00, 11666.67, 13333.33, 15000.00, 18333.33, 21666.67,
25000.00, 33333.34, 41666.67, 50000.00,

AZIMUTH BEARING Y AXIS GRID SYSTEM POINTS (DEGREES)= 0.00, 22.50, 45.00, 67.50, 90.00, 112.50,
135.00, 157.50, 180.00, 202.50, 225.00, 247.50, 270.00, 292.50, 315.00, 337.50,

- AMBIENT AIR TEMPERATURE (DEGREES KELVIN) -

	STABILITY CATEGORY 1	STABILITY CATEGORY 2	STABILITY CATEGORY 3	STABILITY CATEGORY 4	STABILITY CATEGORY 5	STABILITY CATEGORY 6
SEASON 1	296.7000	296.7000	296.7000	294.0000	291.6000	291.6000

- MIXING LAYER HEIGHT (METERS) -

SEASON 1

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.201750E+04	0.201750E+04	0.201750E+04	0.201750E+04	0.201750E+04	0.201750E+04
STABILITY CATEGORY 2	0.134500E+04	0.134500E+04	0.134500E+04	0.134500E+04	0.134500E+04	0.134500E+04
STABILITY CATEGORY 3	0.134500E+04	0.134500E+04	0.134500E+04	0.134500E+04	0.134500E+04	0.134500E+04
STABILITY CATEGORY 4	0.134500E+04	0.134500E+04	0.134500E+04	0.134500E+04	0.134500E+04	0.134500E+04
STABILITY CATEGORY 5	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05
STABILITY CATEGORY 6	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 1

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00002000	0.00011000	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00001000	0.00007000	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00004000	0.00005000	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00001000	0.00007000	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00003000	0.00016000	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00005000	0.00011000	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00003000	0.00018000	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00006000	0.00018000	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00005000	0.00011000	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00001000	0.00005000	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00005000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00004000	0.00005000	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00001000	0.00005000	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00001000	0.00005000	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00006000	0.00018000	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00004000	0.00005000	0.00000000	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 2

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00049000	0.00143999	0.00134999	0.00000000	0.00000000	0.00000000
22.500	0.00021000	0.00083999	0.00081999	0.00000000	0.00000000	0.00000000
45.000	0.00032000	0.00056999	0.00049999	0.00000000	0.00000000	0.00000000
67.500	0.00011000	0.00032000	0.00037000	0.00000000	0.00000000	0.00000000
90.000	0.00028000	0.00079999	0.00127999	0.00000000	0.00000000	0.00000000
112.500	0.00032000	0.00106999	0.00154998	0.00000000	0.00000000	0.00000000
135.000	0.00035000	0.00113999	0.00243998	0.00000000	0.00000000	0.00000000
157.500	0.00021000	0.00074999	0.00182998	0.00000000	0.00000000	0.00000000
180.000	0.00053999	0.00147998	0.00314997	0.00000000	0.00000000	0.00000000
202.500	0.00029000	0.00041000	0.00065999	0.00000000	0.00000000	0.00000000
225.000	0.00033000	0.00039000	0.00021000	0.00000000	0.00000000	0.00000000
247.500	0.00004000	0.00023000	0.00009000	0.00000000	0.00000000	0.00000000
270.000	0.00037000	0.00056999	0.00032000	0.00000000	0.00000000	0.00000000
292.500	0.00025000	0.00065999	0.00032000	0.00000000	0.00000000	0.00000000
315.000	0.00019000	0.00043000	0.00030000	0.00000000	0.00000000	0.00000000
337.500	0.00016000	0.00030000	0.00018000	0.00000000	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 3

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00025000	0.00136999	0.00659993	0.00131999	0.00016000	0.00000000
22.500	0.00014000	0.00065999	0.00424996	0.00068999	0.00007000	0.00000000
45.000	0.00026000	0.00077999	0.00358996	0.00054999	0.00005000	0.00000000
67.500	0.00012000	0.00043000	0.00209998	0.00065999	0.00014000	0.00000000
90.000	0.00012000	0.00088999	0.00693993	0.00310997	0.00025000	0.00002000
112.500	0.00013000	0.00099999	0.00972990	0.00415996	0.00027000	0.00000000
135.000	0.00012000	0.00120999	0.01059989	0.00444995	0.00048000	0.00002000
157.500	0.00017000	0.00079999	0.00773992	0.00367996	0.00034000	0.00000000
180.000	0.00029000	0.00127999	0.01269987	0.00785992	0.00109999	0.00002000
202.500	0.00006000	0.00061999	0.00351996	0.00339997	0.00157998	0.00005000
225.000	0.00014000	0.00034000	0.00131999	0.00056999	0.00032000	0.00000000
247.500	0.00009000	0.00037000	0.00093999	0.00011000	0.00000000	0.00000000
270.000	0.00017000	0.00041000	0.00129999	0.00016000	0.00000000	0.00005000
292.500	0.00008000	0.00049999	0.00152998	0.00016000	0.00002000	0.00002000
315.000	0.00006000	0.00063999	0.00145999	0.00018000	0.00016000	0.00011000
337.500	0.00006000	0.00054999	0.00134999	0.00023000	0.00011000	0.00005000

SEASON 1

STABILITY CATEGORY 4

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00045000	0.00230998	0.00954990	0.02248977	0.01360986	0.00524995
22.500	0.00023000	0.00129999	0.00835992	0.01744982	0.01027990	0.00328997
45.000	0.00042000	0.00177998	0.01406986	0.01945980	0.00632994	0.00122999
67.500	0.00026000	0.00136999	0.01024990	0.01458985	0.00636994	0.00120999
90.000	0.00046000	0.00300997	0.01748982	0.02162978	0.00609994	0.00129999
112.500	0.00032000	0.00300997	0.02269977	0.03304967	0.00629994	0.00120999
135.000	0.00047000	0.00262997	0.02858971	0.03774961	0.00606994	0.00088999
157.500	0.00018000	0.00125999	0.01956980	0.03014969	0.00540995	0.00048000
180.000	0.00057999	0.00209998	0.02180978	0.04110958	0.00849991	0.00037000
202.500	0.00017000	0.00095999	0.00616994	0.01700983	0.00460995	0.00037000
225.000	0.00021000	0.00081999	0.00531995	0.00899991	0.00237998	0.00054999
247.500	0.00014000	0.00037000	0.00230998	0.00246998	0.00065999	0.00011000
270.000	0.00025000	0.00065999	0.00255997	0.00335997	0.00090999	0.00030000
292.500	0.00008000	0.00065999	0.00319997	0.00474995	0.00227998	0.00074999
315.000	0.00021000	0.00083999	0.00424996	0.00992990	0.00531995	0.00195998
337.500	0.00009000	0.00046000	0.00314997	0.00766992	0.00641993	0.00385996

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 5

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00000000	0.00193998	0.00344997	0.00000000	0.00000000	0.00000000
22.500	0.00000000	0.00093999	0.00266997	0.00000000	0.00000000	0.00000000
45.000	0.00000000	0.00262997	0.00632994	0.00000000	0.00000000	0.00000000
67.500	0.00000000	0.00177998	0.00266997	0.00000000	0.00000000	0.00000000
90.000	0.00000000	0.00351996	0.00485995	0.00000000	0.00000000	0.00000000
112.500	0.00000000	0.00376996	0.00981990	0.00000000	0.00000000	0.00000000
135.000	0.00000000	0.00323997	0.01490985	0.00000000	0.00000000	0.00000000
157.500	0.00000000	0.00207998	0.01173988	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.00355996	0.02296977	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00106999	0.00912991	0.00000000	0.00000000	0.00000000
225.000	0.00000000	0.00157998	0.00830992	0.00000000	0.00000000	0.00000000
247.500	0.00000000	0.00088999	0.00316997	0.00000000	0.00000000	0.00000000
270.000	0.00000000	0.00077999	0.00376996	0.00000000	0.00000000	0.00000000
292.500	0.00000000	0.00070999	0.00225998	0.00000000	0.00000000	0.00000000
315.000	0.00000000	0.00104999	0.00426996	0.00000000	0.00000000	0.00000000
337.500	0.00000000	0.00048000	0.00211998	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 6

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00232998	0.00273997	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00133999	0.00177998	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00238998	0.00255997	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00136999	0.00198998	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00336997	0.00364996	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00208998	0.00342997	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00303997	0.00483995	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00143999	0.00303997	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00386996	0.00668993	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00206998	0.00348996	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00419996	0.00474995	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00220998	0.00200998	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00183998	0.00234998	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00145999	0.00189998	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00148998	0.00266997	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00051999	0.00095999	0.00000000	0.00000000	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- VERTICAL POTENTIAL TEMPERATURE GRADIENT (DEGREES KELVIN/METER) -

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 2	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 3	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 4	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 5	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01
STABILITY CATEGORY 6	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01

- WIND PROFILE POWER LAW EXPONENTS -

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01
STABILITY CATEGORY 2	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01
STABILITY CATEGORY 3	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00
STABILITY CATEGORY 4	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00
STABILITY CATEGORY 5	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00
STABILITY CATEGORY 6	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00

- SOURCE INPUT DATA -

C A R D	T A P E	SOURCE NUMBER	SOURCE TYPE	X COORDINATE (M)	Y COORDINATE (M)	EMISSION HEIGHT (M)	BASE ELEV-ATION (M)	- SOURCE DETAILS DEPENDING ON TYPE -
X		1011	STACK	0.00	0.00	40.00	0.00	GAS EXIT TEMP (DEG K)= 300.00, GAS EXIT VEL. (M/SEC)= 12.00, STACK DIAMETER (M)= 0.900, HEIGHT OF ASSO. BLDG. (M)= 0.00, WIDTH OF ASSO. BLDG. (M)= 0.00, WAKE EFFECTS FLAG = 0

- SOURCE STRENGTHS (GRAMS PER SEC) -

SEASON 1	SEASON 2	SEASON 3	SEASON 4
1.00000E+00			

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1011 **

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES)	166.670	333.330	500.000	666.670	833.330	1000.000	1333.330	1666.670	2000.000
	- CONCENTRATION -								
337.500	0.1312E-01	0.1379E+00	0.2406E+00	0.2947E+00	0.3064E+00	0.2943E+00	0.2432E+00	0.2002E+00	0.1563E+00
315.000	0.1662E-01	0.1841E+00	0.3245E+00	0.3994E+00	0.4165E+00	0.4012E+00	0.3328E+00	0.2751E+00	0.2304E+00
292.500	0.1194E-01	0.1572E+00	0.2824E+00	0.3470E+00	0.3605E+00	0.3460E+00	0.2854E+00	0.2348E+00	0.1958E+00
270.000	0.1072E-01	0.1206E+00	0.2130E+00	0.2608E+00	0.2707E+00	0.2598E+00	0.2149E+00	0.1777E+00	0.1493E+00
247.500	0.3760E-02	0.4255E-01	0.9604E-01	0.1338E+00	0.1469E+00	0.1448E+00	0.1224E+00	0.1021E+00	0.8602E-01
225.000	0.4726E-02	0.6609E-01	0.1418E+00	0.1911E+00	0.2075E+00	0.2042E+00	0.1730E+00	0.1448E+00	0.1224E+00
202.500	0.6319E-02	0.7736E-01	0.1431E+00	0.1779E+00	0.1839E+00	0.1748E+00	0.1421E+00	0.1156E+00	0.9570E-01
180.000	0.1146E-01	0.1282E+00	0.2214E+00	0.2621E+00	0.2644E+00	0.2484E+00	0.2000E+00	0.1623E+00	0.1343E+00
157.500	0.2638E-02	0.3245E-01	0.6563E-01	0.8381E-01	0.8759E-01	0.8383E-01	0.6871E-01	0.5622E-01	0.4670E-01
135.000	0.5832E-02	0.4313E-01	0.7758E-01	0.9756E-01	0.1032E+00	0.1005E+00	0.8489E-01	0.7150E-01	0.6102E-01
112.500	0.3988E-02	0.3945E-01	0.6289E-01	0.7151E-01	0.7132E-01	0.6709E-01	0.5477E-01	0.4538E-01	0.3850E-01
90.000	0.3730E-02	0.3649E-01	0.5718E-01	0.6392E-01	0.6392E-01	0.6097E-01	0.5123E-01	0.4360E-01	0.3788E-01
67.500	0.2053E-02	0.1996E-01	0.3248E-01	0.3899E-01	0.4137E-01	0.4115E-01	0.3635E-01	0.3206E-01	0.2875E-01
45.000	0.2162E-02	0.3627E-01	0.7167E-01	0.9335E-01	0.1018E+00	0.1021E+00	0.9022E-01	0.7913E-01	0.7020E-01
22.500	0.5360E-02	0.7946E-01	0.1384E+00	0.1639E+00	0.1676E+00	0.1603E+00	0.1330E+00	0.1108E+00	0.3374E-01
0.000	0.1954E-01	0.2361E+00	0.3851E+00	0.4470E+00	0.4538E+00	0.4325E+00	0.3573E+00	0.2959E+00	0.2487E+00

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES)	2333.330	2666.670	3000.000	3333.330	3666.670	4000.000	4333.330	4666.670	5000.000
	- CONCENTRATION -								
337.500	0.1409E+00	0.1207E+00	0.1048E+00	0.9209E-01	0.8163E-01	0.7311E-01	0.6593E-01	0.5985E-01	0.5466E-01
315.000	0.1954E+00	0.1681E+00	0.1466E+00	0.1292E+00	0.1149E+00	0.1032E+00	0.9332E-01	0.8494E-01	0.7776E-01
292.500	0.1654E+00	0.1418E+00	0.1232E+00	0.1083E+00	0.9610E-01	0.8613E-01	0.7773E-01	0.7061E-01	0.6452E-01
270.000	0.1272E+00	0.1100E+00	0.9639E-01	0.8536E-01	0.7625E-01	0.6881E-01	0.6249E-01	0.5711E-01	0.5248E-01
247.500	0.7327E-01	0.6328E-01	0.5533E-01	0.4889E-01	0.4358E-01	0.3923E-01	0.3554E-01	0.3240E-01	0.2971E-01
225.000	0.1045E+00	0.9055E-01	0.7940E-01	0.7033E-01	0.6287E-01	0.5665E-01	0.5142E-01	0.4696E-01	0.4313E-01
202.500	0.8048E-01	0.6881E-01	0.5968E-01	0.5239E-01	0.4648E-01	0.4161E-01	0.3755E-01	0.3411E-01	0.3117E-01
180.000	0.1131E+00	0.9684E-01	0.8415E-01	0.7401E-01	0.6572E-01	0.5898E-01	0.5331E-01	0.4851E-01	0.4440E-01
157.500	0.3936E-01	0.3369E-01	0.2924E-01	0.2569E-01	0.2277E-01	0.2040E-01	0.1841E-01	0.1672E-01	0.1527E-01
135.000	0.5261E-01	0.4598E-01	0.4067E-01	0.3627E-01	0.3260E-01	0.2957E-01	0.2699E-01	0.2477E-01	0.2285E-01
112.500	0.3315E-01	0.2903E-01	0.2577E-01	0.2306E-01	0.2081E-01	0.1896E-01	0.1737E-01	0.1601E-01	0.1483E-01
90.000	0.3323E-01	0.2957E-01	0.2661E-01	0.2406E-01	0.2191E-01	0.2012E-01	0.1857E-01	0.1722E-01	0.1603E-01
67.500	0.2584E-01	0.2349E-01	0.2154E-01	0.1977E-01	0.1824E-01	0.1694E-01	0.1580E-01	0.1478E-01	0.1388E-01
45.000	0.6252E-01	0.5632E-01	0.5120E-01	0.4667E-01	0.4279E-01	0.3952E-01	0.3666E-01	0.3415E-01	0.3194E-01
22.500	0.8028E-01	0.6979E-01	0.6144E-01	0.5460E-01	0.4893E-01	0.4427E-01	0.4030E-01	0.3692E-01	0.3399E-01
0.000	0.2117E+00	0.1829E+00	0.1600E+00	0.1415E+00	0.1262E+00	0.1136E+00	0.1030E+00	0.9400E-01	0.8624E-01

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1011 (CONT.) **

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES)	6666.670	8333.330	10000.000	11666.670	13333.330	15000.000	18333.330	21666.670	25000.000
	- CONCENTRATION -								
337.500	0.3711E-01	0.2732E-01	0.2119E-01	0.1711E-01	0.1422E-01	0.1206E-01	0.9102E-02	0.7210E-02	0.5917E-02
315.000	0.5335E-01	0.3958E-01	0.3088E-01	0.2505E-01	0.2090E-01	0.1779E-01	0.1350E-01	0.1073E-01	0.8837E-02
292.500	0.4393E-01	0.3241E-01	0.2518E-01	0.2036E-01	0.1694E-01	0.1438E-01	0.1087E-01	0.8623E-02	0.7082E-02
270.000	0.3660E-01	0.2748E-01	0.2164E-01	0.1769E-01	0.1485E-01	0.1270E-01	0.9716E-02	0.7778E-02	0.6435E-02
247.500	0.2050E-01	0.1526E-01	0.1194E-01	0.9705E-02	0.8111E-02	0.6911E-02	0.5252E-02	0.4181E-02	0.3442E-02
225.000	0.2396E-01	0.2243E-01	0.1762E-01	0.1437E-01	0.1204E-01	0.1028E-01	0.7844E-02	0.6265E-02	0.5173E-02
202.500	0.2125E-01	0.1571E-01	0.1223E-01	0.9906E-02	0.8258E-02	0.7021E-02	0.5319E-02	0.4225E-02	0.3472E-02
180.000	0.3049E-01	0.2266E-01	0.1772E-01	0.1441E-01	0.1205E-01	0.1027E-01	0.7818E-02	0.6234E-02	0.5141E-02
157.500	0.1040E-01	0.7676E-02	0.5967E-02	0.4828E-02	0.4021E-02	0.3415E-02	0.2584E-02	0.2050E-02	0.1684E-02
135.000	0.1619E-01	0.1226E-01	0.9729E-02	0.7935E-02	0.6742E-02	0.5787E-02	0.4453E-02	0.3581E-02	0.2973E-02
112.500	0.1068E-01	0.8210E-02	0.6588E-02	0.5462E-02	0.4640E-02	0.4008E-02	0.3115E-02	0.2525E-02	0.2110E-02
90.000	0.1173E-01	0.9179E-02	0.7433E-02	0.6203E-02	0.5296E-02	0.4594E-02	0.3593E-02	0.2927E-02	0.2456E-02
67.500	0.1053E-01	0.8350E-02	0.6845E-02	0.5762E-02	0.4953E-02	0.4319E-02	0.3405E-02	0.2790E-02	0.2351E-02
45.000	0.2383E-01	0.1872E-01	0.1524E-01	0.1276E-01	0.1093E-01	0.9498E-02	0.7452E-02	0.6083E-02	0.5111E-02
22.500	0.2390E-01	0.1804E-01	0.1427E-01	0.1169E-01	0.9842E-02	0.8436E-02	0.6476E-02	0.5201E-02	0.4317E-02
0.000	0.5370E-01	0.4453E-01	0.3497E-01	0.2849E-01	0.2385E-01	0.2035E-01	0.1552E-01	0.1240E-01	0.1025E-01

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES)	33333.340	41666.672	50000.000
	- CONCENTRATION -		
337.500	0.3935E-02	0.2562E-02	0.2326E-02
315.000	0.6001E-02	0.4467E-02	0.3517E-02
292.500	0.4789E-02	0.3555E-02	0.2793E-02
270.000	0.4410E-02	0.3304E-02	0.2613E-02
247.500	0.2335E-02	0.1737E-02	0.1366E-02
225.000	0.3530E-02	0.2636E-02	0.2080E-02
202.500	0.2352E-02	0.1748E-02	0.1374E-02
180.000	0.3505E-02	0.2618E-02	0.2065E-02
157.500	0.1138E-02	0.8446E-03	0.6632E-03
135.000	0.2048E-02	0.1540E-02	0.1222E-02
112.500	0.1473E-02	0.1117E-02	0.8919E-03
90.000	0.1726E-02	0.1315E-02	0.1054E-02
67.500	0.1664E-02	0.1273E-02	0.1024E-02
45.000	0.3537E-02	0.2741E-02	0.2198E-02
22.500	0.2975E-02	0.2238E-02	0.1777E-02
0.000	0.7012E-02	0.5248E-02	0.4152E-02

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) FROM ALL SOURCES COMBINED **

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES) - CONCENTRATION -

	166.670	333.330	500.000	666.670	833.330	1000.000	1333.330	1666.670	2000.000
337.500	0.1312E-01	0.1379E+00	0.2406E+00	0.2947E+00	0.3064E+00	0.2943E+00	0.2432E+00	0.2002E+00	0.1669E+00
315.000	0.1662E-01	0.1841E+00	0.3245E+00	0.3994E+00	0.4165E+00	0.4012E+00	0.3328E+00	0.2751E+00	0.2304E+00
292.500	0.1194E-01	0.1572E+00	0.2824E+00	0.3470E+00	0.3605E+00	0.3460E+00	0.2854E+00	0.2348E+00	0.1958E+00
270.000	0.1072E-01	0.1206E+00	0.2130E+00	0.2608E+00	0.2707E+00	0.2598E+00	0.2149E+00	0.1777E+00	0.1493E+00
247.500	0.3760E-02	0.4255E-01	0.9604E-01	0.1338E+00	0.1469E+00	0.1448E+00	0.1224E+00	0.1021E+00	0.8602E-01
225.000	0.4726E-02	0.6609E-01	0.1418E+00	0.1911E+00	0.2075E+00	0.2042E+00	0.1730E+00	0.1448E+00	0.1224E+00
202.500	0.6919E-02	0.7736E-01	0.1431E+00	0.1779E+00	0.1839E+00	0.1748E+00	0.1421E+00	0.1156E+00	0.9570E-01
180.000	0.1146E-01	0.1282E+00	0.2214E+00	0.2621E+00	0.2644E+00	0.2484E+00	0.2000E+00	0.1623E+00	0.1343E+00
157.500	0.2638E-02	0.3245E-01	0.6563E-01	0.8381E-01	0.8759E-01	0.8383E-01	0.6871E-01	0.5622E-01	0.4670E-01
135.000	0.5832E-02	0.4313E-01	0.7758E-01	0.9756E-01	0.1032E+00	0.1005E+00	0.8489E-01	0.7150E-01	0.6102E-01
112.500	0.3988E-02	0.3945E-01	0.6283E-01	0.7151E-01	0.7132E-01	0.6709E-01	0.5477E-01	0.4538E-01	0.3850E-01
90.000	0.3730E-02	0.3649E-01	0.5718E-01	0.6392E-01	0.6392E-01	0.6097E-01	0.5123E-01	0.4360E-01	0.3788E-01
67.500	0.2053E-02	0.1996E-01	0.3248E-01	0.3899E-01	0.4137E-01	0.4115E-01	0.3635E-01	0.3206E-01	0.2875E-01
45.000	0.2162E-02	0.3627E-01	0.7167E-01	0.9335E-01	0.1018E+00	0.1021E+00	0.9022E-01	0.7913E-01	0.7020E-01
22.500	0.5360E-02	0.7946E-01	0.1384E+00	0.1639E+00	0.1676E+00	0.1603E+00	0.1330E+00	0.1108E+00	0.9374E-01
0.000	0.1954E-01	0.2361E+00	0.3851E+00	0.4470E+00	0.4538E+00	0.4325E+00	0.3573E+00	0.2959E+00	0.2487E+00

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES) - CONCENTRATION -

	2333.330	2666.670	3000.000	3333.330	3666.670	4000.000	4333.330	4666.670	5000.000
337.500	0.1409E+00	0.1207E+00	0.1048E+00	0.9209E-01	0.8163E-01	0.7311E-01	0.6593E-01	0.5985E-01	0.5466E-0
315.000	0.1954E+00	0.1661E+00	0.1466E+00	0.1292E+00	0.1149E+00	0.1032E+00	0.9332E-01	0.8494E-01	0.7776E-0
292.500	0.1654E+00	0.1418E+00	0.1232E+00	0.1083E+00	0.9610E-01	0.8613E-01	0.7773E-01	0.7061E-01	0.6452E-0
270.000	0.1272E+00	0.1100E+00	0.9639E-01	0.8536E-01	0.7625E-01	0.6881E-01	0.6249E-01	0.5711E-01	0.5248E-0
247.500	0.7327E-01	0.6328E-01	0.5533E-01	0.4889E-01	0.4358E-01	0.3923E-01	0.3554E-01	0.3240E-01	0.2971E-0
225.000	0.1045E+00	0.9055E-01	0.7940E-01	0.7033E-01	0.6287E-01	0.5665E-01	0.5142E-01	0.4696E-01	0.4313E-0
202.500	0.8048E-01	0.6881E-01	0.5968E-01	0.5239E-01	0.4648E-01	0.4161E-01	0.3755E-01	0.3411E-01	0.3117E-0
180.000	0.1131E+00	0.9684E-01	0.8415E-01	0.7401E-01	0.6572E-01	0.5898E-01	0.5331E-01	0.4851E-01	0.4440E-0
157.500	0.3936E-01	0.3369E-01	0.2924E-01	0.2569E-01	0.2277E-01	0.2040E-01	0.1841E-01	0.1672E-01	0.1527E-
135.000	0.5261E-01	0.4598E-01	0.4067E-01	0.3627E-01	0.3260E-01	0.2957E-01	0.2699E-01	0.2477E-01	0.2285E-
112.500	0.3315E-01	0.2903E-01	0.2577E-01	0.2306E-01	0.2081E-01	0.1896E-01	0.1737E-01	0.1601E-01	0.1483E-
90.000	0.3323E-01	0.2957E-01	0.2661E-01	0.2406E-01	0.2191E-01	0.2012E-01	0.1857E-01	0.1722E-01	0.1603E-
67.500	0.2584E-01	0.2349E-01	0.2154E-01	0.1977E-01	0.1824E-01	0.1694E-01	0.1580E-01	0.1478E-01	0.1388E-
45.000	0.6252E-01	0.5632E-01	0.5120E-01	0.4667E-01	0.4279E-01	0.3952E-01	0.3666E-01	0.3415E-01	0.3194E-
22.500	0.8028E-01	0.6979E-01	0.6144E-01	0.5460E-01	0.4893E-01	0.4427E-01	0.4030E-01	0.3692E-01	0.3399E-
0.000	0.2117E+00	0.1829E+00	0.1600E+00	0.1415E+00	0.1262E+00	0.1136E+00	0.1030E+00	0.9400E-01	0.8634E-

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) FROM ALL SOURCES COMBINED (CONT.) **

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES)	6666.670	8333.330	10000.000	11666.670	13333.330	15000.000	18333.330	21666.670	25000.
	- CONCENTRATION -								
337.500	0.3711E-01	0.2732E-01	0.2119E-01	0.1711E-01	0.1422E-01	0.1206E-01	0.9102E-02	0.7210E-02	0.5317E-0
315.000	0.5335E-01	0.3958E-01	0.3088E-01	0.2505E-01	0.2090E-01	0.1779E-01	0.1350E-01	0.1073E-01	0.8837E-0
292.500	0.4393E-01	0.3241E-01	0.2518E-01	0.2036E-01	0.1694E-01	0.1438E-01	0.1087E-01	0.8623E-02	0.7082E-0
270.000	0.3660E-01	0.2748E-01	0.2164E-01	0.1769E-01	0.1485E-01	0.1270E-01	0.9716E-02	0.7778E-02	0.6435E-0
247.500	0.2050E-01	0.1526E-01	0.1194E-01	0.9705E-02	0.8111E-02	0.6911E-02	0.5252E-02	0.4181E-02	0.3442E-0
225.000	0.2996E-01	0.2243E-01	0.1762E-01	0.1437E-01	0.1204E-01	0.1028E-01	0.7844E-02	0.6265E-02	0.5173E-0
202.500	0.2125E-01	0.1571E-01	0.1223E-01	0.9906E-02	0.8258E-02	0.7021E-02	0.5319E-02	0.4225E-02	0.3472E-0
180.000	0.3049E-01	0.2266E-01	0.1772E-01	0.1441E-01	0.1205E-01	0.1027E-01	0.7818E-02	0.6234E-02	0.5141E-0
157.500	0.1040E-01	0.7676E-02	0.5967E-02	0.4828E-02	0.4021E-02	0.3415E-02	0.2584E-02	0.2050E-02	0.1684E-0
135.000	0.1619E-01	0.1226E-01	0.9729E-02	0.7995E-02	0.6742E-02	0.5787E-02	0.4453E-02	0.3581E-02	0.2973E-0
112.500	0.1068E-01	0.8210E-02	0.6588E-02	0.5462E-02	0.4640E-02	0.4008E-02	0.3115E-02	0.2525E-02	0.2110E-0
90.000	0.1179E-01	0.9179E-02	0.7433E-02	0.6203E-02	0.5296E-02	0.4594E-02	0.3593E-02	0.2927E-02	0.2456E-0
67.500	0.1053E-01	0.8350E-02	0.6845E-02	0.5762E-02	0.4953E-02	0.4319E-02	0.3405E-02	0.2790E-02	0.2351E-0
45.000	0.2383E-01	0.1872E-01	0.1524E-01	0.1276E-01	0.1093E-01	0.9498E-02	0.7452E-02	0.6083E-02	0.5111E-0
22.500	0.2390E-01	0.1804E-01	0.1427E-01	0.1169E-01	0.9842E-02	0.8436E-02	0.6476E-02	0.5201E-02	0.4317E-0
0.000	0.5970E-01	0.4459E-01	0.3497E-01	0.2849E-01	0.2385E-01	0.2035E-01	0.1552E-01	0.1240E-01	0.1025E-0

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES)	33333.340	41666.672	50000.000
	- CONCENTRATION -		
337.500	0.3935E-02	0.2962E-02	0.2326E-02
315.000	0.6001E-02	0.4467E-02	0.3517E-02
292.500	0.4789E-02	0.3555E-02	0.2793E-02
270.000	0.4410E-02	0.3304E-02	0.2613E-02
247.500	0.2235E-02	0.1737E-02	0.1366E-02
225.000	0.3530E-02	0.2636E-02	0.2080E-02
202.500	0.2352E-02	0.1748E-02	0.1374E-02
180.000	0.3505E-02	0.2618E-02	0.2065E-02
157.500	0.1138E-02	0.8446E-03	0.6632E-03
135.000	0.2048E-02	0.1540E-02	0.1222E-02
112.500	0.1473E-02	0.1117E-02	0.8919E-03
90.000	0.1726E-02	0.1315E-02	0.1054E-02
67.500	0.1664E-02	0.1273E-02	0.1024E-02
45.000	0.3597E-02	0.2741E-02	0.2198E-02
22.500	0.2975E-02	0.2238E-02	0.1777E-02
0.000	0.7012E-02	0.5248E-02	0.4152E-02

** END OF ISCLT PROGRAM, 1 SOURCES PROCESSED **************************************

$ logoff
EEDVER1 logged out at 23-FEB-1987 14:23:14.959)2t:7°(M
NO CARRIER

The Graphical Exposure Modeling System (GEMS) User's Guide is available upon request.

Appendix III. Technical Support for Permit Conditions

Table of Contents

Page No

Appendix III: Technical Support for Permit Conditions.................. III-1

1. Control Techniques and Removal Efficiencies...................................... III-1
    - 1.1 Air Pollution Control Devices (APCDs)............................... III-5
        - 1.1.1 Electrostatic Precipitator.. III-5
        - 1.1.2 Wet Electrostatic Precipitator.................................... III-7
        - 1.1.3 Fabric Filter.(Baghouse) III-7
        - 1.1.4 Quench Chamber.. III-9
        - 1.1.5 Wet/Dry Scrubber (Spray Dryer).............................. III-12
        - 1.1.6 Venturi Scrubber.. III-13
    - 1.2 APCD Efficiencies... III-14
    - 1.3 Metals Partitioning... III-17
2. Sampling and Analysis Requirements.. III-19

1. CONTROL TECHNIQUES AND REMOVAL EFFICIENCIES

Many metals are of concern in hazardous waste incineration because of the possible adverse human health effects associated with exposure to emissions of these elements and/or their compounds from the stacks of the incinerators. Metals of primary interest are arsenic (symbol: As), barium (Ba), beryllium (Be), chromium (Cr), cadmium (Cd), lead (Pb), mercury (Hg), antimony (Sb), silver (Ag), and thallium (Tl).

Incineration may change the form of the elements in waste streams, but it cannot destroy them. Furthermore, incineration may result in the formation of compounds and/or physical forms of the elements that may be more dangerous to human health than were the original wastes. Most metals will leave an incinerator combustion zone as vapors, but upon cooling will condense to form small particulates. Most particulates can be recovered efficiently with proper APCDs, but if not recovered they will be released to the atmosphere in the vicinity of the incineration facility. When inhaled by humans, these metals will settle in the lungs, from which they will either pass into the blood stream as toxic agents, or remain in the lungs as irritants or as carcinogens.

This section presents an overview of the various APCDs and treatment trains that are applicable, including process descriptions, operating and maintenance information, and ranges of metal-specific removal efficiencies.

The performance of APCDs depends on a number of incinerator design and operating parameters, on the compatibility of APCDs to the process and pollutants to be controlled, and on the specific performance requirements demanded by the process and applicable air pollution control regulations. The process variables that must be considered in evaluating the operation of the facility APCD system include:

- Gas flow;
- Inlet and outlet gas temperature;
- Liquid flow (in wet systems);
- Pressure drop across the unit;
- Physical and chemical properties of the gas;
- Particulate concentration;

- Particulate size distribution;
- Physical and chemical properties of particulates; and
- Emission levels of regulated pollutants.

In most cases this information may be best obtained from detailed emission evaluations (trial burns).

Incineration equipment and APCDs should be visually inspected daily or weekly to verify their operational status. Table III-1 provides the recommended inspection and maintenance frequency for common incineration equipment. Detailed inspections are recommended on a much less frequent schedule as specified by the particular equipment manufacturer. However, a specific piece of equipment may occasionally indicate a particular problem. In this event, to comply with RCRA performance specifications, a detailed inspection of the equipment components is necessary to prevent potential component failure. Problems are generally manifested through a variety of performance indicators. Table III-2 provides a list of indicators of poor performance, the equipment problems generally associated with these indicators, and the recommended maintenance and troubleshooting procedures. Generally, if a facility is unable to correct the problems by operational adjustment (within the limits of the operating permit), then the equipment may require detailed inspection and possible repair. Appropriate troubleshooting and repairs should be implemented to prevent a potential negative impact on operational safety and to assure compliance with permit requirements. The types of inspection, maintenance, and troubleshooting recommended in Tables III-1 and III-2, in most cases, require that the incinerator facility be shut down.

Table III-1
Recommended Inspection and Maintenance Frequency

	I&M Frequency				
	Operation and monitoring equipment			Emergency systems	
Equipment/Parameters	Calibration	Inspection	Service	Alarms	Waste Cutoffs
Incinerator Equipment	--	Daily	(1)	--	--
Waste Feed/Fuel Systems	(2)	Daily	(1)	Weekly	Weekly
O_2 and CO Monitors	Weekly	Continuous	(1)	Weekly	Weekly
Gas Flow Monitors:					
• Direct gas velocity	Weekly	Continuous	(1)	Weekly	Weekly
• Indirect fan amps	6 Months	Continuous	--	Weekly	Weekly
Other Incinerator Monitoring Equipment (flame scanners, air blowers, etc.)	--	Daily	(1)	Weekly	Weekly
APCE	--	Weekly	(1)	--	--
APCE Support Systems	--	Daily	(1)	Weekly	Weekly
APCE Performance Instrumentation	Weekly	Daily	(1)	Weekly	Weekly

(1) Equipment manufacturer recommendation.
(2) Equipment manufacturer recommendation or no less than monthly.

Sources: Acurex 1986.
Frankel 1987c.

Table III-2

General Maintenance and Troubleshooting Air Pollution Control Equipment

Equipment	Indicators	Problems	Recommended maintenance and troubleshooting
Quencher	Erratic outlet temperature	• Partially plugged nozzles • High variation in incinerator feed moisture • Low gas flow rate (<30 ft/sec) • Water droplet impinging on thermocouple	• Inspect and replace plugged nozzles • Control moisture feed to incinerator • Increase gas flow rate to design range • Relocate thermocouple; replace defective nozzles
	Consistently high outlet temperature	• Plugged nozzles • Lower water flow rate and high temperature • Excessive gas velocity (>50 ft/sec)	• Inspect and replace plugged nozzles • Calibrate water flowmeter to adjust for evaporation loss • Reduce gas flow rate
Venturi scrubber	Erratic pressure differential	• Plugged nozzles • Erosion • Corrosion • Adjustable throat diameter is too wide	• Inspect headers, flanges, and nozzles • Reduce throat diameter and adjust liquid flow rate • Inspect throat regularly for deposits and wear
Absorption scrubber	Surging pressure differential (>10 percent)	• Face velocity in excess of 12 ft/sec • Plugged tray sections • Nonuniform scrubber liquor distribution • Leaking seals • Localized plugging of packing • Hole in the packing • Flooding	• Inspect spray nozzles, water flow rate weir boxes, and downcomers for proper operation and seals. Inspect packing; adjust caustic concentration to 15-20 percent • Decrease liquid flow rate • Check for plugging of packing
Fabric filter (baghouse)	Excessive pressure differential	• Excessive gas flow rate • Bag binding (high dust loadings) • Leaking air lock or dampers • Faulty cleaning mechanism • Excessive dust accumulation in clean side of bags	• Reduce gas flowrate; check bleed air • Inspect cleaning mechanism; replace bags • Check proper temperature of gas to prevent condensation • Inspect for proper removal of collected ash from hoppers

Operation and performance monitoring instrumentation should also be subjected to a routine inspection and maintenance program. This instrumentation includes liquid waste flowmeter, water flowmeters, pH meters, CO, temperature, O_2 continuous recorders, differential pressure indicators, and opacity meters. The inspection of this equipment is normally carried out on a continuous basis, because most are on-line monitors with continuous response records. The maintenance program for this equipment includes routine service and calibration activities. Service requirements are normally specified by the manufacturer. Response and calibration checks should be performed daily since these instruments are subject to drift and reduced sensitivity.

1.1 Air Pollution Control Devices (APCDs)

1.1.1 Electrostatic Precipitator

1.1.1.1 Process description

An electrostatic precipitator (ESP) removes particles from the flue gas stream by imparting a negative electrical charge on the particles. The negatively charged particles are attracted and retained by positively charged collection electrodes. The particles are removed from the electrodes into collection hoppers by rapping. The operation occurs within an enclosed chamber; a high-voltage transformer and a rectifier provide the power input. The chamber has a shell made of metal or Fiberglass Reinforced Plastic. Suspended within this shell are the grounded collecting electrodes (plates). Suspended between the plates are the discharge electrodes, which are negatively charged with voltages ranging from 20 to 100 kilovolts.

Several important gas stream and particulate factors dictate how well an ESP will collect a given particulate matter. These factors include the following:

- Gas input velocity;
- Moisture content;
- Particle size distribution;
- Particle resistivity (partially temperature dependent);
- Collection plate area;

- Electrode spacing and configuration; and
- Voltage differential.

Table III-3 presents normal ranges for the parameters affecting ESP efficiency. Outside of these values, the unit will not be operating at its optimum collection efficiency.

Table III-3
Normal Ranges for the Parameters Affecting ESP Efficiency

Parameter	Range
Gas input velocity	2-4 ft/s
Particle size	most effective for < 1μm particles
Particle resistivity	10^4 - 10^{10} ohm-cm
Collection plate area to flow rate ratio	200 to > 600 ft^2/1000 cfm
Pressure drop	1.00 in

Source: Frankel, I. 1987a (January 16).

1.1.1.2 Operation and maintenance

Proper maintenance of the unit is important to ensure that it is operating at peak efficiency. According to a 1975 survey by the Air Pollution Control Association, the five most common precipitator problem components (APCA 1978, as cited in Theodore and Buonicore 1984) are as follows:

- Discharge electrodes;
- Ash removal system;
- Collection plates;
- Rappers; and
- Insulators.

Table III-4 presents a preventive maintenance checklist for a typical ESP.

1.1.2 Wet Electrostatic Precipitator

1.1.2.1 Process description

Wet ESPs are essentially the same technology as dry ESPs with two important distinctions:

- A wet spray is included in the inlet section for cooling, gas adsorption, and coarse particle collection.
- The collection electrode is wetted to flush away the collected particles.

Wet ESPs are a relatively new technology and are generally used for applications where the potential for explosion is high or where particulates are very sticky. The maintenance checklist provided for the ESP in Table III-4 applies to wet ESPs as well.

The parameters that affect the collection efficiency of wet ESPs are the liquid to gas ratio, of which a typical value is 5 gal/1000 scf, and pressure drop, which should be between 0.1 and 1.0 inches (Water Gauge) (Frankel 1987a).

1.1.2.2 Operation and maintenance

The wet ESP should be washed periodically to avoid irregularities in the operation of the precipitator caused by accumulation of particles on the walls.

1.1.3 Fabric Filter (Baghouse)

1.1.3.1 Process description

Fabric filters remove dust from dust-laden gas by passing the gas through a fabric bag. The cleaned gas exits from one side of the filter while the dust is collected on the other side. The collected dust is removed from the bags by three methods: mechanical shaking (shakers), reverse flow back-flushing at low pressure (reverse air), and reverse flow back-flushing at slightly higher pressure (pulsed air).

Baghouses are very efficient for gases containing small particles.

TABLE III-4
Preventive Maintenance Checklist for a Typical Electrostatic Precipitator

---

<u>Daily</u>
1.Record electrical readings and transmissometer data.
2.Check operation of hoppers and ash removal system.
3.Carefully investigate cause of abnormal arcing in transformer - rectifier enclosures and bus duct.

<u>Weekly</u>
1.Check rapper operation.
2.Inspect electric control devices.

<u>Monthly</u>
1.Check operation of standby top-housing pressurizing fan and thermostat.
2.Check hopper level alarm operation.

<u>Quarterly</u>
1.Check and clean rapper and vibrator switch contacts.
2.Check transmissometer calibration.

<u>Semiannual</u>
1.Clean and lubricate access-door dog bolt and hinges.
2.Clean and lubricate interlock covers.
3.Clean and lubricate test connections.
4.Check exterior for visual signs of deterioration, and abnormal vibration, noise, leaks.
5.Check transformer-rectifier liquid and surge-arrestor spark gap.

<u>Annual</u>
1.Conduct internal inspection.
2.Clean top housing or insulator compartment and all electrical insulating surfaces.
3.Examine and clean all contactors and inspect tightness of all electrical connections.
4.Clean and inspect all gasketed connections.
5.Check and adjust operation of switchgear.
6.Check and tighten rapper insulator connections.
7.Observe and record areas of corrosion.

<u>Situational</u>
1.Record gas load readings during and after each outage.
2.Clean and check interior of control sets during each outage of more than 72 hours.
3.Clean all internal bushings during outages of more than 5 days.
4.Inspect condition of all grounding devices during each outage over 72 hours.
5.Clean all hopper buildups during each outage.
6.Inspect and record amount and location of residual dust deposits on electrodes during each outage of 72 hours or longer.
7.Check all alarms, interlocks, and other safety devices during each outage.

Sources: Theodore and Buonicore, 1984.
Frankel 1987c.

The following parameters influence the collection efficiency of a fabric filter (Frankel 1987a):

- Pressure drop, which is controlled by bag cleaning, ranges between 2.0 and 7.0 inches (Water Gauge).
- Air-to-cloth ratio, which is expressed as the total gas flow rate divided by the total cloth area available for filtration and is baghouse-type dependent:

  Shaker: $< 1\ m^3/min \cdot m^2$

  Reverse air: $0.32 - 2.2\ m^3/min \cdot m^2$

  Pulsed air: $0.95 - 2.5\ m^3/min \cdot m^2$.

- Temperature, which is dependent on the type of filter fabric. Thermal erosion may double for a temperature rise of 20°F above the optimum.
- Humidity, which can cause failure due to burning and blinding. Such failures would affect the pressure drop across the fabric filter.

1.1.3.2 Operation and maintenance

Table III-5 presents a preventive maintenance checklist for a typical fabric filter.

1.1.4 Quench Chamber

1.1.4.1 Process description

Quench chambers usually precede scrubber equipment in the treatment train, and are used to reduce the temperature of hot gases leaving the incinerator. The quench chamber also reduces water evaporation in downstream scrubbing equipment (which is associated with generation of caustic particles in caustic scrubbers), and protects the downstream equipment from high temperature damage.

The quench chamber operates by passing the hot gases through a water spray. The spray is generated by one of three basic designs:

- Air and water nozzles;
- High pressure sequenced spray nozzles; and

- Orifice plates.

The type of quench chamber used depends on the composition of quench water and exhaust gas and the type of APCD that follows the quench chamber. Air and water nozzles require a particle-free freshwater feed so that the nozzles do not become clogged. An air and water nozzle quench chamber requires less water than the other types because it produces small uniform droplets that cover the exhaust area efficiently.

With high pressure sequenced spray nozzles, only certain sprays are activated at first. Then, as the temperature increases, other spray nozzles are activated to keep the gas at a constant temperature. These units also must have fresh particle-free makeup water.

With orifice plates, water is forced through perforated plates to create a spray. Unlike the above devices, quench water may be recycled because of the large perforations in the plates.

The following parameters affect the efficiency of the unit:

- Gas temperature at inlet;
- Amount of water recycled and its particulate content;
- Gas velocity; and
- Pressure drop.

TABLE III-5
Fabric Filter Routine Maintenance Schedule

Item	Check	Daily	Wkly	Mnth'y	Qrt'ly	Yearly
Dust pickup areas	Dust capture effectiveness	X				
	Monitoring flue gas volume	X				
	Test hood face velocity				X	
	Rebalance system					X
System dampers	Proper operation		X			
	Proper valve seating				X	
	Wear or corrosion					X
Bags	Observe stack (visually or with opacity meter)	X				
	Spot-check bag tension (inside collectors)		X			
	Spot-check bag condition and seating			X		
	Thoroughly inspect bags				X	
Cleaning system	Monitor cleaning cycle	X				
	Check compressed air	X				
	Inspect mechanical components for wear			X		
	Replace high-wear parts (whether needed or not)					X
Control system	Observe all indicators on panel	X				
	Log ΔP	X				
	Blow out manometer lines		X			
	Check compressed air system, including filters		X			
	Activate key shutdown or bypass controls		X			
	Verify accuracy of temperature-indicating equip.		X			
	Check accuracy of all other indicating equipment			X		
System fan	Check drive components		X			
	Inspect for corrosion and material buildup			X		
	Check for vibration		X			
Outlet stack	Check emission visually or monitor opacity meter	X				
	Calibrate opacity meter				X	
Discharge system	Monitor discharge rate	X				
	Check all moving parts for wear and alignment			X		
General	Check normal and abnormal visual and audible conditions	X				
	Inspect system for corrosion			X		
	Inspect door gaskets				X	
	Check for dust buildup in ducts				X	
	Inspect paint				X	
	Inspect baffles, hopper duct, etc. for wear					X
	Inspect general structural integrity of system					X

Sources: Theodore and Buonicore. 1984.
Frankel. 1987c.

The proper values for the parameters affecting efficiency are as follows: the gas outlet temperature should be below 500°F; the gas velocity should be between 30 ft/sec and 50 ft/sec; and the pressure drop across the quench chamber should be between 2 and 6 inches (Water Gauge). Quench water is sometimes recycled. Since this can cause reentrainment of particulates back into the gas stream, however, for optimum operation only makeup water should be used.

1.1.4.2 Operation and maintenance

A regular maintenance program for these quench chambers should be followed so that the nozzles do not become plugged and effective water spray is assured.

1.1.5 Wet/Dry Scrubber (Spray Dryer)

1.1.5.1 Process description

In the wet/dry scrubber, hot gases are passed through a fine mist of a dilute alkali slurry. The water in the slurry absorbs acids from the flue gas and the acids react with the alkali solids in the slurry to form salts. Water is lost through evaporation, leaving the salts and any unreacted alkali behind as a dry powder. This particle-laden flow then goes to a fabric filter or an ESP to remove the particulates. Wet/dry scrubbers are considered cleaner control systems than wet scrubbers, mainly because the waste material is dry particulates and no further liquid treatment is required, which significantly reduces the waste volume.

The parameters that affect the collection efficiency of the wet/dry scrubbers are (Frankel 1987a):

- Liquid-to-gas ratio which ranges between 0.25 and 0.30 gal/1000 acf;
- Gas input velocity with a range between 2 and 6 ft/s; and
- Pressure drop between 10 and 12 inches (Water Gauge).

1.1.5.2 Operation and maintenance

Table III-6 presents maintenance procedures for wet/dry scrubbers.

TABLE III-6
Wet/Dry Scrubber Maintenance Procedures

Spray nozzels should be kept clean. Particle size of the slurry should be smaller than the diameter of the nozzles. Pre-filtering is usually used to guarantee that adequate particle size is maintained.
Sludge buildup at the bottom of the scrubber should be removed periodically.
Spray nozzles should be checked periodically for clogging.
The slurry flow rate and composition should be carefully monitored to guarantee that the water evaporates completely.

Sources: Theodore and Buonicore1984.

Frankel 1987c.

1.1.6 Venturi Scrubber

1.1.6.1 Process description

In the venturi scrubber, a liquid is introduced into a constricted area. High velocity gas is also introduced to shear the liquid into fine droplets and to allow a large surface area for mass transfer.

The parameters that affect the collection efficiency are (Frankel 1987a):

- Liquid-to-gas ratio, which ranges between 5 and 45 gal/1000 acf;
- Gas input velocity with a range of 100 to 400 ft/s; and
- Pressure drop, which should be close to design pressure (typically 20 to 100 in Water Gauge).

The collection efficiency for a venturi scrubber generally improves with increases in gas velocity, liquid-to-gas ratio, and pressure drop.

1.1.6.2 Operation and maintenance

Table III-7 presents a preventive maintenance checklist for a typical venturi scrubber.

TABLE III-7
Venturi Scrubber Routine Maintenance Procedures

Check for wear (abrasion/erosion).

Check for corrosion on all scrubber internal surfaces.

Check for excessive buildup, particularly in the wet/dry zone.

Check for excessive scaling. This is caused mainly by changes in the chemical composition of the makeup water, but may also be caused by process changes such as changes in pH, chemical composition of the dust, reduced liquor recycle rate, increase in the inlet loading, or failure of the solids removal system.

Check the nozzles for damage. Repair or replacement may be necessary.

Check for solids buildup in blowdown lines. Cleaning may be effected without system shutdown, and a flush connection may be installed to prevent this condition in the future.

Check for corrosion and leaks in lines and vessel, in particular where protective liners may have deteriorated.

Check operation of the mist eliminator. Formation of droplets can be caused by excessive gas flow rate, plugged drains from the droplet eliminator, or condensation in the outlet duct. Check structural supports for structural integrity and smooth operation.

Sources: Theodore and Buonicore1984.
Frankel 1987c.

1.2 APCD Efficiencies

In Table III-8, the various APCDs previously described are assigned conservatively estimated efficiencies for particulates and toxic metals. The conservative nature of the estimates is stressed, since a multitude of feed waste compositions, incinerator designs, and operating conditions will be encountered in any real-world situation, and it is not always possible to achieve the highest theoretical efficiency. In fact, with proper system design, stable, optimized operation, and good maintenance, higher efficiencies than are shown in the table might be achieved.

A number of factors should be kept in mind when Table III-8 is used. These factors are as follows:

- Most toxic metals, or their compounds, condense as solids if incinerator combustion gases are cooled. A meagre fund of information suggests that most metals generally co-condense to form particulates of mixed metallic and nonmetallic composition.

- Of the toxic metals, mercury is the least predictable and least apt to condense prior to emission from the system stack. Its degree of recovery above 400°F is generally slight, or zero.

- A quench chamber is a commonly used item whose primary function is to cool incineration or boiler flue gas by the evaporation of water injected into the hot gas stream. In order to function as an APCD, water in excess of evaporative demand must be furnished. A quench is virtually always used in tandem with one or more other APCDs.

- Cyclones are almost never used alone. They are moderately efficient in removing large particulates from a moving gas stream, and thus in reducing the loading of more efficient particulate removal devices downstream of the cyclone.

- Venturi scrubbers are frequently used devices. Their efficiency, especially on submicron particles, increases as the pressure drop (power consumption) increases.

- ESPs are not widely used with hazardous waste incinerators, although they are commonly used on municipal waste incinerators and on coal-burning utility boilers. Their efficiency can be varied with a number of design parameters, but for high efficiency on small particulates, more than single stage units are necessary. Up to four stages in tandem have been seen in the industry.

- Both Wet ESPs (WESP) and Ionizing Wet Scrubbers (IWS) are finding a limited market in the U.S. Since the data on these units have come from facilities having two or more APCD series, there is little if any data outside of manufacturers' literature that permits one to estimate their pollutant removal efficiency as a single unit.

- Several rather complex, but apparently highly efficient wet scrubbers have become available during the past 3 to 4 years. No new facility should be built without a careful consideration of these scrubbers.

- Fabric filters (baghouses) have not been commonly used on hazardous waste incinerators, but have been widely used on utility boilers and municipal waste incinerators. They are bulky and expensive, and require careful operation. However, when used in tandem with upstream APCDs, especially spray dryers (wet/dry scrubbers), they are enormously efficient on both soluble gases and on particulates. Furthermore, if gas temperatures are below 400°F, these combination units are also very efficient on mercury emissions.

- At most facilities where data indicate high gas and particulate (including toxic metal) removal efficiencies, there are usually two to four APCDs in series. It is expected that this type of installation will become the norm for large-scale commercial incinerators that burn large quantities of mixed liquids, solids, and sludges.

TABLE III-8
Air Pollution Control Devices (APCDs) and Their Conservatively Estimated Efficiencies for Controlling Toxic Metals

APCD	POLLUTANT				
	Ba, Be	Ag	Cr	As,Sb,Cd, Pb, Tl	Hg
*WS	50	50	50	40	30
*VS-20	90	90	90	20	20
*VS-60	98	98	98	40	40
ESP-1	95	95	95	80	0
ESP-2	97	97	97	85	0
ESP-4	99	99	99	90	0
*WESP	97	97	96	95	60
*FF	95	95	95	90	50
*PS	95	95	95	95	80
SD/FF; SD/C/FF	99	99	99	95	90
DS/FF	98	98	98	98	50
*FF/WS	95	95	95	90	50
ESP-1/WS; ESP-1/PS	96	96	96	90	80
ESP-4/WS' ESP-4/PS	99	99	99	95	85
*VS-20/WS	97	97	97	96	80
**WS/IWS	95	95	95	95	85
*WESP/VS-20/IWS	99	99	98	97	90
C/DS/ESP/FF; C/DS/C/ESP/FF	99	99	99	99	98
SD/C/ESP-1	99	99	98	95	85

* It is assumed that flue gases have been precooled in a quench. If gases are not cooled adequately, mercury recoveries will diminish, as will cadmium and arsenic to a lesser extent.
** An IWS is nearly always used with an upstream quench and packed horizontal scrubber.

C = Cyclone
WS = Wet Scrubber including: Sieve Tray Tower
Packed Tower
Bubble Cap Tower
PS = Proprietary Wet Scrubber Design
(A number of proprietary wet scrubbers have come on the market in recent years that are highly efficient on both particulates and corrosive gases. Two such units are offered by Calvert Environmental Equipment Co. and by Hydro-Sonic Systems, Inc.).
VS-20 = Venturi Scrubber, ca. 20-30 in W. G. Δp
VS-60 = Venturi Scrubber, ca. > 60 in W. G. Δp
ESP-1 = Electrostatic Precipitator; 1 stage
ESP-2 = Electrostatic Precipitator; 2 stages
ESP-4 = Electrostatic Precipitator; 4 stages
IWS = Ionizing Wet Scrubber
DS = Dry Scrubber
FF = Fabric Filter (Baghouse)
SD = Spray Dryer (Wet/Dry Scrubber)

It is to be expected that the type of APCD, or train of devices, that must be used with a hazardous waste incinerator will depend on the type of incinerator and the characteristics of the wastes incinerated. Although a large percentage of existing hazardous waste incinerators are not equipped with APCDs, these are nearly all liquid injection incinerators which burn wastes that, for practical purposes, have no ash- or particulate-forming components. When these incinerators are equipped with an APCD, it is likely to be a wet scrubber of simple construction (spray tower or packed tower) preceded by a quench chamber or at least an evaporative cooler.

At the other end of the spectrum, incinerators designed to cope with wastes having a high ash and toxic metals content will generally require an APC train consisting of two to four APCDs. A number of typical APC trains are listed below:

- Quench/wet scrubber;
- Quench/spray dryer/cyclone/ESP;
- Quench/spray dryer/cyclone/fabric filter;
- Quench/wet scrubber/IWS/mist eliminator;
- Quench/WESP/venturi scrubber/packed tower scrubbers;
- Quench/venturi scrubber/packed tower scrubbers; and
- Fabric filter/wet scrubber.

1.3 Metals Partitioning

EPA has developed conservative estimates of the partitioning of metals within combustion processes prior to the APCD. These estimates are based on tests conducted at different firing temperatures (1,600 °F and 2,000°F) and with different levels of chlorine in the waste feed. Both barium and silver are affected by the presence of chlorine in waste feed at the lower combustion temperature and tend to partition to the APCD at significantly higher proportions at higher temperatures (see Table III-9).

TABLE III-9

Conservative Estimates of Metals Partitioning to APCD[1] as a Function of Solids[2] Temperature[3] (%)

	1600°F		2000°F	
Metal[4]	Cl = 0 %	Cl = 1 %	Cl = 0 %	Cl = 1 %
Antimony	100	100	100	100
Arsenic	100	100	100	100
Barium	50	30	100	100
Beryllium	5	5	5	5
Cadmium	100	100	100	100
Chromium	5	5	5	5
Lead	100	100	100	100
Mercury	100	100	100	100
Silver	8	100	100	100
Thallium	100	100	100	100

1 The remaining percentage is contained in the bottom ash of the incinerator.
2 Partitioning for liquids is estimated at 100% for all metals.
3 The combustion gas temperature is estimated to be 100-400°F higher than the solids temperature.
4 Assumptions:

- excess air = 50%
- entrainment = 5%
- waste metals content = 100 ppm for each metal. For a given set of combustion chamber conditions, the maximum amount of metal which will be vaporized will become constant as the metal concentration in the solids increase. As a result, higher concentrations of metals are expected to have lower partitioning factors.

Source: Letter from Dr. Randall Seeker, Energy and Environmental Research Corporation, to Dwight Hlustick, EPA, dated December 7, 1988.

2. SAMPLING AND ANALYSIS REQUIREMENTS

The following discussion outlines the proper procedures for the sampling and analysis of the incnerator system. Analysis of composite samples is required for the waste feed in order to determine the metals feed rates that must be provided by the applicant to the permit writer. Test burns also require the sampling and analysis of the incinerator stack gas, scrubber liquor, and bottom ash so that a mass balance can be performed on the incinerator.

All samples must be analyzed according to the appropriate methods outlined in "Test Methods for Evaluating Solid Wastes: Physical/Chemical Method," EPA SW-846, as incorporated by reference in §260.11. Total chromium emissions measured in accordance with SW-846 are to be used in the analysis unless the applicant's emissions sampling and analysis procedures are capable of reliably determining hexavalent chromium emission rates to the satisfaction of the Administrator. Sampling for particulates should be performed using Method 5 from 40 CFR Part 60 Appendix A. Sampling for all Appendix VIII metals should use the Multiple Metals Train currently being validated. The Multiple Metals Train, as discussed in a memorandum from Larry Johnson (Johnson 1987), includes the following impingers: (1) empty (for condensate collection, may be omitted for a dry source); (2) 5 percent HNO_3 and 10 percent H_2O_2 (will be reduced to 0.1N HNO_3 if research shows it to be adequate); (3) same as 2; (4) 1.5 percent $KMnO_4$ and 10 percent H_2SO_4; and (5) silica gel (to protect the pump and meter).

The analysis procedure consists of two steps: preparation (called digestion) and the analysis itself. The digestion process is dependent on both the analysis procedure and the waste matrix. Table III-9 lists the digestion methods as well as the proper analysis technique and waste matrix for each method. The analysis procedures are pollutant specific. For some metals, up to three methods are applicable depending on the precision of the detection limit desired. See Table III-10 for the proper analysis methods to be used for each metal. In some cases, the analysis method includes its own digestion and the listed digestion methods are not necessary. These methods are footnoted on Table III-10.

Standard methods for the analysis of the glass fiber filter and impinger solution from the Method 5 train are under development (but not yet published). The impinger solution should be slightly acidic (validation studies may suggest 0.1N nitric acid) during sampling, so that any metals that escape the glass fiber filter will be captured in the solution.

For analysis, the filter can be either extracted using acid extraction or completely dissolved by treatment with hydrofluoric acid. The impinger solution should be reduced by evaporation, then treated with acid digestion. Following these steps, the normal aqueous digestion (see Table III-9) and analysis (see Table III-10) may be used.

Analysis for matrix effects (interference) should be performed by the Method of Standard Addition or other appropriate procedures.

Table III-10
Preparation Methods

Methods	Analysis procedure	Waste matrix
3010	ICP, FLAA	Aqueous Only
3020	GFAA	Aqueous Only
3050	FLAA, ICP, or GFAA	Sediment, Sludge, Soil, Filter Particulate Material, and Filter from Stack Sampling Train
3040*	ICP or FLAA	Oils, Greases, or Waxes

*Method 3040 is only recommended for virgin oils or clean used oils. It is not recommended for oils that contain emulsions and particulates. Until EPA's microwave digestion technique is available, use the HNO_3/H_2O_2 combination and procedure from Method 3050 in a condenser rig similar to that used in the old Method 3030 for used or dirty oils. Methods 3010 and 3020 can be used for volatile solvents if the solvent is first carefully evaporated, and the volume replaced with water before completing the procedure.

ICP = Inductively Coupled Plasma Emission Spectroscopy
GFAA = Graphite Furnace Atomic Absorption
FLAA = Flame Atomic Absorption
Source: EPA 1986.

Table III-11
Analysis Methods

Sample	Sampling procedure	Constituent	Analysis method
Flue Gas	EPA Method 5	Particulates	
	Multiple Metals Train	Total Metals*	See methods listed below
		Antimony	7041
	EPA Method 108	Arsenic	7060[b], 7061[b]
		Barium	6010, 7080
	EPA Method 104	Beryllium	6010, 7090, 7091
		Cadmium	6010, 7130, 7131
		Chromium(Total)	6010, 7190, 7191
		Chromium(VI)	7195-7198[a]
		Lead	6010, 7420, 7421
	EPA Method 101A	Mercury	7470[b], 7471[c]
		Silver	6010, 7760[c]
		Thallium	6010, 7841
Other Samples[d]	Composite	Antimony	7040
		Arsenic	7060[b], 7061[b]
		Barium	6010, 7080
		Beryllium	6010, 7090, 7091
		Cadmium	6010, 7130, 7131
		Chromium(Total)	6010, 7190, 7191
		Chromium(VI)	7195-7198[a]
		Lead	6010, 7420, 7421
		Mercury	7470[b], 7471[c]
		Silver	6010, 7760[c]
		Thallium	6010, 7841

* Validation studies indicate Method 101A may have to be run to analyze mercury.

a These chromium(VI) methods are for aqueous matrices only.

b This method includes digestion for aqueous matrices (no digestion method from Table III-12 is necessary).

c This method include digestion for all matrices (no digestion method from Table III-12 is necessary).

d Includes waste feed, bottom ash, and scrubber liquor.

Source: EPA 1986.

REFERENCES

Auer, A., H., F., Correlation of land use and cover with meteorological anomalies. Journal of applied meteorology, Vol. 17, pp. 636-643, May 1978.

Barton, R., G., Energy and Environment Research Corporation, Memoranda of October 19 and 25, 1988, on APCD efficiencies, to Dwight Hlustick, Office of Solid Waste, U.S. Environmental Protection Agency, Washington D.C.

Bonner, T., et al. Monsanto Research Corporation. 1981. Hazardous waste incineration engineering. Park Ridge, N.J.: Noyes Data Corporation.

Frankel, I. 1987a (January 16). Versar Inc. Attachment A: Operating and design parameters for the major air pollution control devices used on hazardous waste incinerator systems. Memorandum to Marc Turgeon. Office of Solid Waste, U.S. Environmental Protection Agency, Washington, D.C.

Frankel, I. 1987b (February 19). Versar Inc. Table 2-5. Fate of selected elements included as constituents of wastes fed to the hazardous waste incinerator at Biebesheim, W. Germany. Memorandum to Marc Turgeon. Office of Solid Waste, U.S. Environmental Protection Agency, Washington, D.C.

Frankel, I. 1987c (May 28). Personal conversation. Versar Inc. Springfield, Va.

Johnson, L. 1987 (July 7). Recommended sampling train for multiple metals determination. Memorandum to "addressees." U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory. Research Triangle Park, N.C.

Perry, R., and Chilton, C. 1973. Chemical engineers' handbook. 5th ed. New York, N.Y.: McGraw-Hill Book Company.

REA. 1978. Research and Education Association. Modern pollution control technology. Vol. I. Air pollution control. New York, N.Y.

Theodore and Buonicore, Eds. 1984. Air pollution control equipment, selection, design, operation and maintenance. New Jersey: Prentice Hall Inc.

USEPA. 1977. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Guidelines for air quality maintenance planning and analysis - Vol. 10 (Revised) - Procedures for evaluating air quality impact of new stationary sources. EPA-450/3-77-001. Research Triangle Park, N.C.

USEPA. 1986. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Guideline on air quality models (Revised). EPA-450/2-78-027R. Research Triangle Park, N.C.

USEPA. 1986. U.S. Environmental Protection Agency, Office of Research and Development. Permitting hazardous waste incinerators: A workshop for hazardous waste incinerator permit writers, inspectors, and operators.

USEPA. 1986. U.S. Environmental Protection Agency, Office of Solid Waste. Test methods for evaluating solid wastes: Physical/chemical method, EPA SW-846. 3rd ed.

USEPA. 1987. U.S. Environmental Protection Agency, Background document supporting the control of emissions of metals and hydrogen chloride from hazardous waste incinerators. To be published.

Appendix IV. Worksheets for Permitters' Use

Table of Contents

Page No

Appendix IV: Worksheets for Permitters' Use

1. Instructions for Completing WORKSHEET 1 .... IV-1
   1.1 Reference Information IV-1
   1.2 Site Information IV-1
   1.3 Requested Maximum Metal and Chlorine Feed Rates IV-2

1. INSTRUCTIONS FOR COMPLETING WORKSHEET 1

These instructions provide guidance for filling out WORKSHEET 1, which requires information on incinerator units, incinerator stacks, and metal and chlorine feed rates by feed system for each incinerator unit.

The form is divided into three sections. Section I requests general reference information, Section II requests site information, and Section III requests desired maximum metal and chlorine feed rates.

The requested metal and chlorine feed rates in Section III must be specified for all feed systems to the incinerator.

1.1 Reference Information

The facility name, address, phone number, and date are requested for the permit writer's recordkeeping information.

A. Facility name

B. Address

C. Phone number

D. Date of submission

1.2 Site Information

This section is divided into three categories: stack parameters, terrain parameters, and dimensions of nearby buildings. These data should be provided separately for each incinerator on the site. The form contains space for five separate incinerator units. If there are more than five units on the site, the applicant should attach additional sheets with the requested parameters fro these units.

A. Stack Parameters — The following parameters are required for the stack through which the incinerator unit in question releases, even if other non-incinerator units are connected to the same stack.

1. Stack height — This is the height in meters of the stack above the base elevation (not the height above sea level). If the stack is on top of a building, the reported height should be

the height of the building plus the height of the stack, so that this value will be the height above the base elevation.

2. Exhaust temperature — This is the exit gas temperature of the plume in degrees Kelvin.

3. Inner stack diameter — This is the inner diameter of the stack at the exit point (top of stack) in meters, i.e., do not include the thickness of the stack walls.

4. Exit velocity — This is the velocity of the plume in meters per second as it exits the stack in question

5. Flow rate — This is the flow rate of the plume in cubic meters per second. This parameter is not necessary if the inner stack diameter and exit velocity are given. Those parameters are perferable over the flow rate, but if they are unavailable, then the exit flow rate is acceptable.

6. Latitude/Longitude or UTMs — These are the coordinates of the stack in question. If these coordinates are not readily available, they may be obtained using the following method: Locate each stack on a U.S. Geological Survey (USGS) topographical map and read from the map axes the latitude/longitude coordinates in degrees/minutes/seconds and the UTM coordinates to the nearest tenth of a kilometer.

B. Terrain parameters — The required terrain parameters are determined using the maximum terrain rise from a topograghic map; the terrain rise is measured out to a 5-km radius from the location of the source. The U. S. Geological Survey (USGS) 7.5 minute map is recommended. A discussion of the rationale for the 5-km distance is provided in Appendix I.

1. Maximum terrain rise — The maximum terrain rise (in meters) occurring within the following three distance ranges from the source is required:

0 - 0.5 km

0 - 2.5 km

0.-5.0 km

The terrain rise is obtained from reading the topographic lines off the map (converting from feet to meters)

2. Shortest distance to fenceline (meters) — This is distance to the facility property boundary closest to the source. If residences are located within

the plant boundaries, then this parameter should be the distance to the nearest residence.

C. Dimensions of nearby buildings — All structures within 5 building heights or 5 projected maximum building widths of the stack(s) should be identified, including structures outside the plant boundary.

1. Distance from the stack (meters)
2. Distance from nearest fenceline (meters)
3. Building height (meters)
4. Building length (meters)
5. Building width (meters)

In addition, each such structure should be clearly identified on a site map.

1.3 Requested Maximum Metal and Chlorine Feed Rates

The feed rates provided here should be the maximum metal and chlorine feed rates ever expected to the system, shown separately by feed system. If waste blending is performed, the data in this section should reflect the resulting waste stream after blending. These feed rates will be written into the permit provided they pass the risk screening. The applicant must attach copies of any supporting documentation of the waste feed rate calculations.

The feed rates must be provided separately for each feed system to the incinerator to allow more flexibility in adjusting feed rates if the risk levels are unacceptable (see attached diagram). Some examples of waste feed systems include:

- Ram feed (solids)
- Conveyor feed (solids)
- Liquid injection (liquids)
- Liquid or fuel injection to afterburner (liquids)

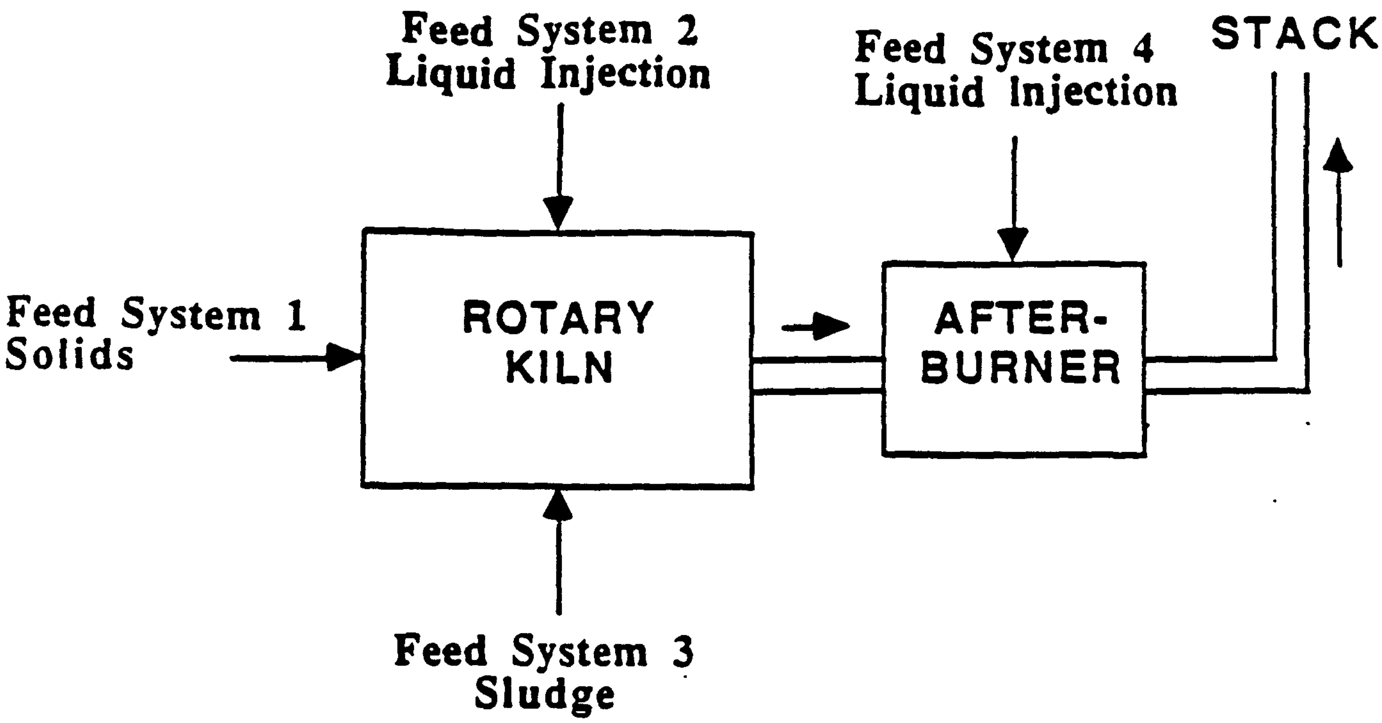


DIAGRAM OF FEED SYSTEMS

WORKSHEET 1
Data Requirements
(if facility has more than five units, attach additional sheets)

FEED RATES

If waste blending is performed, the data provided in this section should be after blending. These feed rates will be written into the permit provided they pass the risk screening

The applicant must also submit copies of any supporting documentation of the waste feed rate calculations for each one of the feed (burner) . ***systems***

A. Maximum Feed Rates by Feed System	**Feed System 1**	**Feed System 2**	**Feed System 3**	**Feed System 4**	**Total for all Feed Systems**
Antimony					
Arsenic					
Barium					
Beryllium					
Cadmium					
Chromium					
Lead					
Mercury					
Silver					
Thallium					
Chlorine					

WORKSHEET 1
Data Requirements
(if facility has more than five units, attach additional sheets)

I. REFERENCE INFORMATION

A. Facility Name ______________________
B. Address ______________________
C. Phone Number ______________________
D. Date of Submission ______________________

II. SITE INFORMATION

A. Stack Parameters	Incinerator Stacks 1	2	3	4	5
1. Stack Height (meters)					
2. Exhaust Temperature (Kelvin)					
3. Inner Stack Diameter (meters)					
4. Exit Velocity (m/second)					
5. Flow Rate (cubic m/sec)					
6. Latitude					
Longitude					
UTM (easting)(km)					
UTM (northing) (km)					
B. Terrain Parameters					
1. Maximum Terrain Rise(meters)					
0 – 0.5 km radius					
0 – 2.5 km radius					
0 – 5.0 km radius					
2. Shortest distance to fenceline					
C. Dimensions of Tallest Buildings*					
1. Distance from Stack (meters)					
2. Distance from nearest fenceline (meters)					
3. Building height (meters)					
4. Building length (meters)					
5. Building width (meters)					

*Consider buildings within 5 building heights or 5 maximum projected widths of the stack.

III. REQUESTED MAXIMUM

WORKSHEET 2

Checklist of Required Results
for Site-Specific Modeling and Risk Analysis
(if facility has more than five units, attach additional sheets)

and the ratio of the MEI concentration to the RAC

Pollutant	RAC (µg/m3)	Source 1 MEI		Source 2 MEI		Source 3 MEI		Source 4 MEI		Source 5 MEI	
		Conc	Risk	Conc	Risk	Conc	Risk	Conc	Risk	Conc	Risk
Antimony	0.3										
Barium	50										
Lead	0.09										
Mercury	0.3										
Silver	3										
Thallium (Oxide)	0.3										
HCl	150 (3 min) 7 (annual)										

WORKSHEET 2

Checklist of Required Results for Site-Specific Modeling and Risk Analysis
(if facility has more than five units, attach additional sheets)

RISK ANALYSIS

Considerations:

Theoretical MEI risk should be calculated (not population-weighted risk or cancer incidence)

The aggregate risk from the carcinogens must be less than or equal to 1E-5

The MEI concentration for each noncarcinogen must be less than or equal to the RAC

For Carcinogens: MEI Risk = Unit Risk X Ambient MEI Concentration

For Noncarcinogens: MEI Risk = Ambient MEI Concentration/RAC

Information To Be Presented:
MEI risk due to each carcinogen and aggregate risk

Pollutant	Unit Risk	Source 1 MEI Conc	Source 1 MEI Risk	Source 2 MEI Conc	Source 2 MEI Risk	Source 3 MEI Conc	Source 3 MEI Risk	Source 4 MEI Conc	Source 4 MEI Risk	Source 5 MEI Conc	Source 5 MEI Risk	MEI Risk Estimates for Combined Sources
Arsenic	4.3E-03											
Beryllium	2.4E-03											
Cadmium	1.8E-03											
Chromium	1.2E-02											
Aggregate MEI cancer risk:	—											

MEI concentration of each non-carcinogen

WORKSHEET 2

Checklist of Required Results
for Site-Specific Modeling and Risk Analysis
(if facility has more than five units, attach additional sheets)

Information to be Presented

The following items must be presented to the Permit Writer after completion of the In-depth modeling.

EPA guideline model used

Terrain type

Receptor grid assumptions

Maximum offsite annual average concentration
(or maximum annual average concentration if people reside on-site)

The selected special receptors

For multiple sources, the predicted concentration for each source separately and combined

The full input file (either in the model output or appended to the results)

The rationale for selection of the meteorological monitoring station including a map showing alternative stations

A site layout map showing the location of all sources and structures*

Building dimensions for structures adjacent to each source

*The following criteria *should be applied: if the distance from a stack to the nearest portion of a building is within* 5 x height of building or 5 x maximum projected width, the building dimensions should be provided.

WORKSHEET 2

Checklist of Required Results for Site-Specific Modeling and Risk Analysis

(if facility has more than five units, attach additional sheets)

Facility Name: ____________________

Address: ____________________

Telephone Number: ____________________

Date: ____________________

MODELING

General Considerations

For the In-depth modeling exercise, the following guidelines must be followed:

1. Must be consistent with the EPA "Guideline on Air Quality Models"

2. Special receptors should be specified for these model runs; these receptors are at the closest distance to the fenceline for each wind direction sector

Appendix V. Hazardous Waste Combustion Air Quality Screening Procedure for RCRA Permit Writers

Table of Contents

Page No

Appendix V: Hazardous Waste Combustion Air Quality Screening Procedure for RCRA Permit Writers

Introduction....................V-1

Step 1: Obtain Permit Data....................V-4

Step 2: Determine the Applicability of the Screening Procedure....................V-10

Step 3: Select the Worst-Case Stack....................V-12

Step 4: Verify Engineering Practice (GEP) Criteria....................V-13

Step 5: Determine the Effective and the Terrain Adjusted Effective Stack Height....................V-15

Step 6: Classify the Site as Urban or Rural....................V-20

Step 7: Identify Maximum Dispersion Coefficients....................V-20

Step 8: Estimate Maximum Ambient Air Concentrations....................V-28

Step 9: Determine Compliance with Regulatory Limits....................V-30

Step 10: Multiple Stack Method (Optional)....................V-32

Appendix A: Rational for the Screening Procedure....................V-49

- Introduction....................V-49
- Development of the Screening Procedure....................V-49
- Rational For Technical Approach / Step-By-Step Description....................V-53

Introduction

The purpose of this screening methodology is to provide a fast, easy method for estimating maximum short-term (hourly and 3-minute averages) and annual average ambient air impacts associated with the burning of metal bearing hazardous waste. The methodology is conservative in nature and estimates dispersion coefficients[1] of a selected number of pollutants.

The emission limits to control metals and HCl impacts from the combustion of hazardous waste are risk-based limits. The applicant must show that the risk to the MEI does not exceed 10^{-5} for carcinogens and the reference air concentrations (RACs) are not exceeded for noncarcinogens. The Tier I and II tables shown in the Metal Guidance Document specify feed rate or emission rate limitations needed to conservatively meet these risk criteria. These tables are based on back-calculating limits using information on worst case modeling scenarios for 26 real and hypothetical incinerators. If an applicant fails to meet the Tier I and Tier II limits, two alternatives are available. (1) Site-specific dispersion modeling (Tier III) can be done or (2) this air quality screening procedure can be used.

There are two advantages to using the screening procedure that can result in a reduction of the cost and time to permit a facility.

- The need to conduct site specific detailed dispersion modeling can be waived if the screening procedure shows that the MEI risk does not exceed 10^{-5} for carcinogens and the RACs are not exceeded.
- For those sites when the nearest meteorological (STAR) station is not representative of the meteorology at the site, this procedure can be used for determining emission limits. If this screen shows that the emissions from the site are adequately protective (i.e., risk is less than 10^{-5}), then the need to collect site-specific meteorological data could be waived.

The screening procedure is likely to be most helpful for facilities with (1) multiple stacks, (2) large distances from the incinerator stack(s) to the site boundary, and (3) complex terrain within 1 to 5 kilometers from the incinerator stack(s).

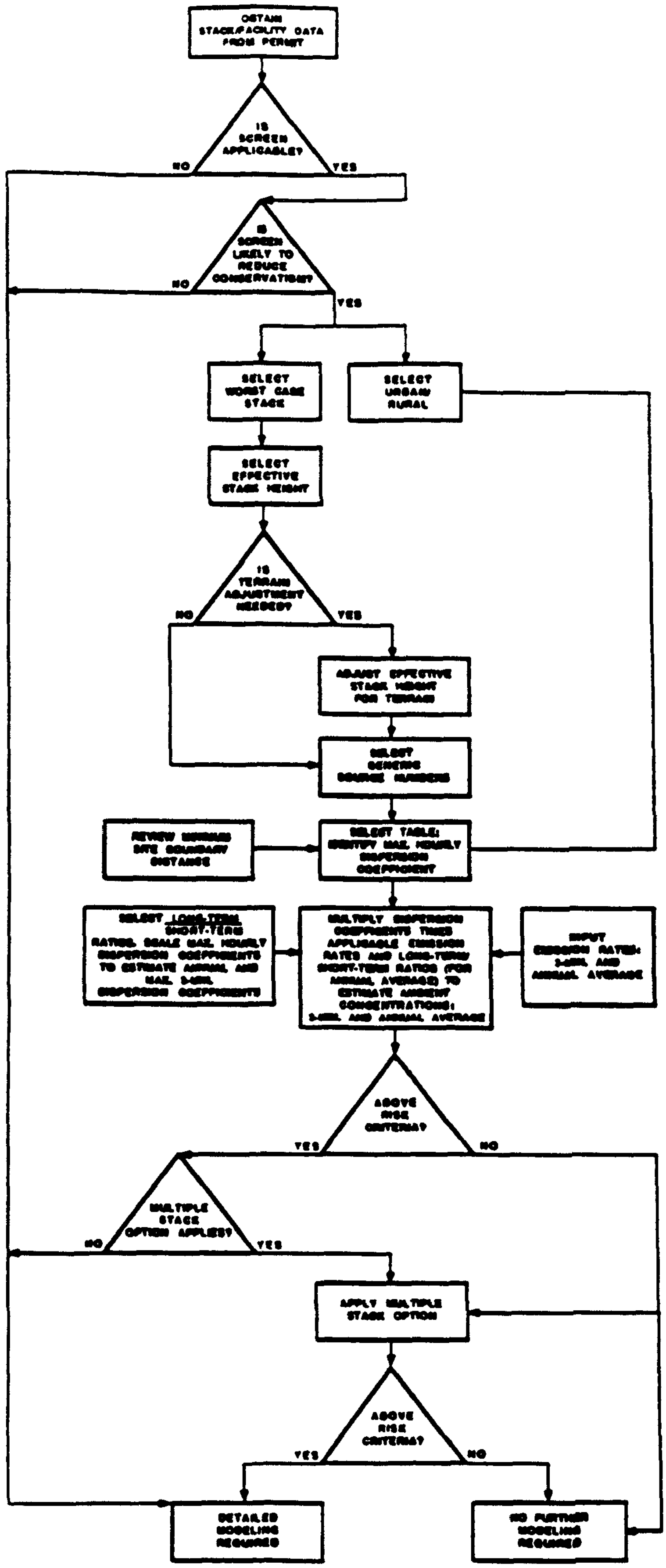
---

1 In this report the term dispersion coefficient refers to normalized concentrations, i.e., ambient air concentrations (ug/m^3) resulting from a source with an emission rate of 1 g/sec.

If, by using this screening procedure, it can be demonstrated that the regulatory short-term and long-term risk criteria (10^{-5} and RACs) can be met, then this could eliminate the need for additional modeling. If, on the other hand, the procedure reveals that risks in excess of 10^{-5} may occur for those pollutants under evaluation then more in-depth modeling would be required.

Figure 1 shows a flow chart of the screening process described in this methodology.

FLOW CHART FOR SCREENING PROCEDURE



The steps involved in the screening methodology are as follows:

Step 1 Obtain Permit Data

Step 2 Determine the Applicability of the Screening Procedure

Step 3 Select the Worst-Case Stack

Step 4 Verify Engineering Practice (GEP) Criteria

Step 5 Determine the Effective Stack Height and Terrain Adjusted Effective Stack Height

Step 6 Classify the Site as Urban or Rural

Step 7 Identify Maximum Dispersion Coefficients

Step 8 Estimate Maximum Ambient Air Concentrations

Step 9 Determine Compliance with Regulatory Limits

Step 10 Multiple Stack Method

These steps, described in greater detail, as well as the theory and data on which the methodology is based are presented below.

Step 1: Obtain Permit Data

The data needed for this step is taken from the data submitted for WORKSHEET 1 of Appendix IV.

Complete the following table for the source:[2]

2 Worksheet space is provided for three stacks. If the facility under review has additional stacks, they should be included in the analysis.

Stack Data

	Stack No. 1	Stack No.2	Stack No.3
Physical stack height (m)	___	___	___
Exhaust temperature (K)	___	___	___
Flow rate (m^3/sec)	___	___	___

Site Data

Minimum distance from stack(s) to property boundary (m) ____________

Maximum terrain rise (for three distance ranges):
(Not required if the highest stack is less than 10 meters in height)

________(m)	________(m)	________(m)
0 – 0.5 km	0 – 2.5 km	0 – 5 km

Nearby Building Dimensions:
Consider all buildings within five building heights or five maximum projected widths of the stack(s). From this group, select the building with the greatest height and fill in the spaces below.

Building height (m) ________________

Maximum projected building width (m) ________________

Distance from facility to nearest shoreline (km) ________________

Valley width (km) ________________

Emissions Data[3]
Stack #___

Pollutant	Annual average emission rate (g/sec)	Maximum 3-minute emission rate (g/sec)
Antimony	________	
Arsenic	________	
Barium	________	
Beryllium	________	
Cadmium	________	
Chromium	________	
Lead	________	
Mercury	________	
Silver	________	
Thallium	________	
Hydrogen Chloride	________	________

3 For facilities that do not have emissions data from a trial burn, refer to Tab D(1) for the procedure to estimate emission rates.

Emissions Data[4]
Stack #___

Pollutant	Annual average emission rate (g/sec)	Maximum 3-minute emission rate (g/sec)
Antimony	________	
Arsenic	________	
Barium	________	
Beryllium	________	
Cadmium	________	
Chromium	________	
Lead	________	
Mercury	________	
Silver	________	
Thallium	________	
Hydrogen Chloride	________	________

4 For facilities that do not have emissions data from a trial burn, refer to Tab D(1) for the procedure to estimate emission rates.

Emissions Data[5]
Stack #___

Pollutant	Annual average emission rate (g/sec)	Maximum 3-minute emission rate (g/sec)
Antimony	________	
Arsenic	________	
Barium	________	
Beryllium	________	
Cadmium	________	
Chromium	________	
Lead	________	
Mercury	________	
Silver	________	
Thallium	________	
Hydrogen Chloride	________	________

5 For facilities that do not have emissions data from a trial burn, refer to Tab D(1) for the procedure to estimate emission rates.

Total Emissions From Stacks

Pollutant	Annual average emission rate	Maxium 3-minute emission rate
Antimony	_____ + _____ + _____ = _____	
Arsenic	_____ + _____ + _____ = _____	
Barium	_____ + _____ + _____ = _____	
Beryllium	_____ + _____ + _____ = _____	
Cadmium	_____ + _____ + _____ = _____	
Lead	_____ + _____ + _____ = _____	
Mercury	_____ + _____ + _____ = _____	
Silver	_____ + _____ + _____ = _____	
Thallium	_____ + _____ + _____ = _____	
HCl	_____ + _____ + _____ = _____	_____ + _____ + _____ = _____

Step 2: Determine the Applicability of the Screening Procedure

For each application of this screening procedure, the user must consider: (1) the acceptability of using the procedure for the facility under review, (i.e., are the dispersion coefficients sufficiently conservative[6]), and (2) the likelihood that the procedure may reduce the degree of conservatism and allow greater emissions compared to the limits tabulated in Tiers I and II. Both conditions must be satisfied in order for the screening procedure to be most useful.

(A) Acceptability of the Screening Procedure for a Specific Site.

Fill in the following data to evaluate this condition:

	Yes	No
Is the facility in a Valley >1 km in width ?	___	___
Is the terrain rise within 1 km of the facility less than the physical stack height of the tallest stack? (Only applies to stacks ≥20 meters in height)	___	___
Is the distance to the nearest shoreline >5 km? (Only applies to facilities with stacks > 20 meters in height)	___	___
Is the closest property boundary >5 times the building height and >5 times the maximum projected building width?[7] (Only applies to facilities with a stack height < 2.5 times the building height)	___	___

If the answer is yes to all of the preceding questions that are relevant to the facility, then the screening procedure is acceptable pending concurrence with these results by the regional meteorologist or the Permit Assistance Team (PAT). Proceed to the next step to

---

6 The term conservative in this procedure means that concentrations and risks tend to be overestimated rather than underestimated.

7 Refer to the building selected in Step 1.

determine whether the screening procedure is likely to allow higher emission rates than Tiers I and II for the facility under review.

(B) Applications Most Likely to Benefit from the Screening Procedure.

In some circumstances the screening procedure can be more restrictive than Tier I and II. Under the following conditions, however, the screening procedure should be less restrictive, while still ensuring that the risk does not exceed 10^{-5} for the MEI. Under these conditions the screen is most useful.[8]

The following table should be completed to evaluate whether the screening procedure would be less restrictive. An affirmative response to any of the questions below indicates that the screen should be of benefit.

	Yes	No
The facility has multiple stacks with sub-substantially different release specifications (e.g., stack heights differ by >50 percent, exit temperatures differ by >50 K, or exit flow rates differ by more than a factor of 2).	___	___
The terrain does not reach physical stack height within 1 km of the incinerator, when the stack is greater than 20 m high and is in complex terrain[9].	___	___
The distance to the nearest facility boundary is greater than the distance shown in the Table 1 below for the specified land use and the terrain adjusted effective stack height of worst-case stack.[10]	___	___

---

8 Using the screening procedure is perhaps most advantageous for sites located in complex terrain and other areas where representative meteorological data are unavailable. If any one of the conditions shown in Step 2(B) is met and subsequent estimates of ambient concentrations are shown to be below the risk criteria, then the loss of time to permit the facility (typically 1 to 1.5 years) could be avoided and the high cost (from $50,000 to $100,000) to collect and process a meteorological data set could be waived by the permit writer with the concurrence of the Regional meteorologists or the PAT.

9 Complex terrain refers to to applications where the maximum terrain rise within 5 kilometers of a facility exceeds the physical height of the facility's shortest stack.

10 Refer to Step 5.

Table 1

Terrain adjusted effective stack height range (m)	Distance (m) Urban	Rural
1 – 9.9	200	200
10 – 14.9	200	250
15 – 19.9	200	250
20 – 24.9	200	350
25 – 30.9	200	450
31 – 41.9	200	550
42 – 52.9	250	800
53 – 64.9	300	1000
65 – 112.9	400	1200
113+	700	2500

If the answer is yes to any of the questions above that are relevant to the facility under review, then this screen is likely to allow higher emissions than Tiers I and II. However, if the answer to all of the above questions is no, then this procedure may not allow higher emissions than Tiers I and II (i.e., may not be less conservative). The permit reviewer may now proceed to Steps 3 through 9.

Step 3: Select the Worst-Case Stack

If the facility has several incinerator stacks, a worst-case stack must be chosen to conservatively represent release conditions at the facility. Follow the steps below to identify the worst case-stack.

Apply the following equation to each stack:

$K = HVT$

where:

K = an arbitrary parameter accounting for the relative influence of the stack height and plume rise.

H = Physical stack height (m)

V = Flow rate (m^3/sec)

T = Exhaust temperature (Kelvin).

Complete the following table to compute the "K" value for each stack:

Stack No.	Stack height (m)	x	Flow rate (m^3/sec)	x	Exit temp. (Kelvin)	=	K
1	________	x	________	x	________	=	____
2	________	x	________	x	________	=	____
3	________	x	________	x	________	=	____

Select the stack with the lowest "K" value. This is the worst-case stack that will be used for Steps 4 through 9.

Worst-Case Stack is identified as Stack No. ____

Step 4: Verify Engineering Practice (GEP) Criteria

Confirm that the selected worst-case stack meets Good Engineering Practice (GEP) criteria. The stack height to be used in the subsequent steps of this procedure must not be greater than the maximum GEP.

Maximum and minimum GEP stack heights are defined as follows:

GEP (minimum) = H + (1.5 x L)

GEP (maximum) = greater of 65 m or H + (1.5 x L)

where:

H = Height of a nearby structure measured from ground level elevation at the base of the stack (refer to the building selected in Step 1)

L = The lesser dimension of the height or projected width of a nearby structure (refer to the building selected in Step 1)

Record the following data:

Stack height (m) = _____

H (m) = ______

L (m) = ______

Then compute the following:

GEP (minimum) (m) = _________

GEP (maximum) (m) = _________

If the physical height of the worst-case stack exceeds the maximum GEP, then use the maximum GEP stack height for the subsequent steps of this analysis.

If the physical height of the worst case-stack is less than the minimum GEP, then use generic source number 11 as the selected source for further analysis and proceed directly to Step 6.

If the physical height of the worst case-stack is between the minimum and maximum GEP, then use the actual physical stack height for the subsequent steps of this analysis.

Step 5: Determine the Effective Stack Height and the Terrain Adjusted Effective Stack Height

The effective stack height (i.e., the height of the effluent release) is an important factor in air pollution modeling. The effective stack height is the physical height of the stack plus plume rise. As specified in Step 4, the stack height used to estimate the effective stack height must not exceed GEP requirements. Plume rise is a function of the stack exit gas temperature and flow rate. In this analysis, the effective stack height is used to select the generic source that represents the dispersion characteristics of the facility under study. For facilities located in flat terrain and for all facilities with worst case stacks less than or equal to 10 meters in height, generic sources are selected strictly on the basis of effective stack height. In all other cases, the effective stack height is further adjusted to take into account the terrain rise within the vicinity of the facility (Terrain Adjusted Effective Stack Height). The "terrain adjusted effective stack height" is then used to select the generic source that represents the dispersion characteristics of the facility.

Follow the steps below to identify the effective stack height, the terrain adjusted effective stack height (where applicable) and the corresponding generic source number.

(A) Go to Table 2 and find the plume rise value corresponding to the stack temperature and exit flow rate for the worst case stack determined in Step 3.

Plume rise = _________(m)

(B) Add the plume rise to the physical stack height of the worst-case stack to determine the effective stack height.

Stack Height (m)[11]	+	Plume Rise (m)	=	Effective Stack Height (m)
__________	+	________	=	________________

[11] As shown in Step 4(A), stack height should be set to maximum GEP stack height if the physical stack height exceeds GEP.

Distance Range (km)	Generic Source No.(s)	Maximum Dispersion Coefficient (µg/m³/m/sec)
	Step 5(G)	
0.0 - 0.5	________	________
>0.5 - 2.5	________	________
>2.5 - 5.0	________	________
>5.0 - 20.0	1	46.7

Select the highest maximum average hourly dispersion coefficient from above and record it in the space provided below.

Maximum Average Hourly Dispersion Coefficient = __________ ($\mu g/m^3/g/sec$)

(D) Select long-term/short-term ratio for long-term analysis.[19]

The maximum average annual dispersion coefficient is approximated by multiplying the maximum hourly dispersion coefficient (identified in Step 7(C)) by the appropriate ratio selected from Table 6, which follows. Note that the final generic source number(s) (from Steps 5(D) or 5(G)), urban/rural designation (from Step 6), and complex or noncomplex terrain designation are used to select the appropriate scaling factor. The following information is needed to complete this step:

19 In this ratio, long-term refers to an annual time period and short-term refers to an hourly time period.

1. Generic Source Number(s)[20] (see Steps 5(D) or 5(G))

Step 5(D)

Distance range	Generic source number(s)
0.0 - 5.0	_________

or

Step 5(G) - (nonflat)

0.0 - 0.5	_________
>0.5 - 2.5	_________
>2.5 - 5.0	_________

2. Terrain Type - Use the noncomplex designation for all sources located in flat terrain, for all sources where the physical stack height of the worst case stack is less than or equal to 10 meters (regardless of terrain data), for all sources where the worst case stack is less than the minimum GEP, and for those sources where all of the TAESHs in Step 5(F) are > zero. Use the complex terrain designation if any of the terrain adjusted stack heights in Step 5(F) is less than or equal to zero. Record the selection below.

Complex _________ Noncomplex _________

3. Land Use (See Step 6) _________ (Urban) _________ (Rural)

20 For those sites with terrain adjustment, generic source numbers for each distance range will be considered.

Table 6
95 th Percentile of Long-Term/Short-Term Ratios

Noncomplex Terrain			Complex Terrain		
Source	Urban	Rural	Source	Urban	Rural
1	0.019	0.014	1	0.020	0.053
2	0.033	0.019	2	0.020	0.053
3	0.031	0.018	3	0.030	0.057
4	0.029	0.017	4	0.051	0.047
5	0.028	0.017	5	0.067	0.039
6	0.028	0.017	6	0.059	0.034
7	0.031	0.015	7	0.036	0.031
8	0.030	0.013	8	0.026	0.024
9	0.029	0.011	9	0.026	0.024
10	0.029	0.008	10	0.017	0.013
11	0.018	0.015	11	0.020	0.053

First select the generic source number and the LT/ST ratio for all stacks, then fill in the following worksheet.

Long-Term/Short-Term Ratio Worksheet

	Urban/Rural	Effective stack height (m)	TAESH (m)* (nonflat)			Generic source #s			LT/ST ratio		
			0-0.5	>0.5-2.5	>2.5-5.0	0-0.5	>0.5-2.5	>2.5-5.0	0-0.5	>0.5-2.5	>2.5-5.0
Worst-case stack	______	______	___	___	___	___	___	___	___	___	___

* Refer to Step 5(F).

If the facility has only one generic source number, then record the computed LT/ST ratio in the space provided below. If the facility has multiple generic source numbers, then record the highest computed LT/ST value in the space provided below.

LT/ST Ratio ________

Multiply the LT/ST ratio recorded above by the maximum hourly dispersion coefficient selected in Step 7(C) to estimate the maximum annual dispersion coefficient. Record this parameter in the space provided below

Maximum Average Annual Dispersion Coefficient ________ ($\mu g/m^3/g/sec$)

Step 8: Estimate Maximum Ambient Air Concentrations

Maximum annual average ambient air concentrations are estimated by multiplying the maximum long-term dispersion coefficient found above (see Steps 7(C) and 7(D)) times the facility's maximum annual average emission rate (see Step 1). Maximum short-term (3-minute) ambient air concentrations are estimated by first multiplying the maximum hourly dispersion coefficient by a scaling factor of 1.64[21] and then by the facility's maximum 3-minute average emission rate (see Step 1).

Using the variables identified below, complete the following worksheet to determine maximum ambient air concentrations.

ER_{AN} = Total (all stacks) maximum annual average emission rate for pollutant "N" (g/sec)

ER_{3N} = Total (all stacks) maximum 3-minute average emission rate for "N" pollutant (g/sec)

DC = Maximum hourly average dispersion coefficient ($\mu g/m^3$)/(g/sec) (see Step 7(C))

C = Ambient concentration ($\mu g/m^3$)

R= Long-term/short-term ratio (see Step 7(D)).

---

21 The use of the 1.64 scaling factor is consistent with the procedure outlined in "Turners Workbook of Atmospheric Dispersion Estimates."

Multiply dispersion coefficients times emissions to estimate ambient concentrations for each averaging period.[22]

Pollutant	Annual averages $ER_{AN} \times DC \times R = C$	3-min. averages $ER_{3N} \times DC \times 1.64 = C$
Antimony	____ x ____ x ____ = ____	
Arsenic	____ x ____ x ____ = ____	
Barium	____ x ____ x ____ = ____	
Beryllium	____ x ____ x ____ = ____	
Cadmium	____ x ____ x ____ = ____	
Lead	____ x ____ x ____ = ____	
Mercury	____ x ____ x ____ = ____	
Silver	____ x ____ x ____ = ____	
Thallium	____ x ____ x ____ = ____	
HCl	____ x ____ x ____ = ____	____ x ____ x 1.64 = ____

22 Note that the maximum annual average and the maximum 3-minute average emission rates from Step 1 are to be transferred into the appropriate columns of this table. If only annual averages are available, these are used for all columns (with caution) as defaults.

Step 9: Determine Compliance with Regulatory Limits

(A) For the noncarcinogenic compounds (antimony, barium, lead, mercury, silver, thallium, and hydrogen chloride), use the following equation to determine compliance:

$$\frac{\text{Dispersion Coefficient } (\mu g/m^3/g/sec) \times \text{Emission } (g/sec)^{23}}{\text{RAC } (\mu g/m^3)} \leq 1.0$$

where:

RAC = Reference Air Concentration of the pollutant being evaluated.

If the ratio for any pollutant is greater than 1, then the results indicate an exceedance of the risk screening criteria.

The RACs for each pollutant are listed below:

Pollutant	RAC
Antimony	0.3
Barium	50
Lead	0.09
Mercury	0.3
Silver	3
Thallium	0.3
HCl (3 minute)	150
(annual)	7

Compute the ratio for each pollutant and list the results in the spaces provided.

23 When determining compliance use the maximum annual average emission rate (summed across all stacks). Alternately, when determining compliance on a 3-minute basis (e.g., for hydrogen chloride), use the maximum 3-minute emission rate (summed across all stacks).

	Ratio	Exceedance	Compliance
Antimony	________	_____	_____
Barium	________	_____	_____
Lead	________	_____	_____
Mercury	________	_____	_____
Silver	________	_____	_____
Thallium	________	_____	_____
HCl (3 minute)	________	_____	_____
(annual)	________	_____	_____

(B) For the carcinogenic compounds (arsenic, beryllium, cadmium, and chromium), use the following equation to determine compliance.

Actual Risk = Dispersion Coefficient ($\mu g/m^3/g/sec$) x Emission[24] (g/sec) x Unit Risk ($m^3/\mu g$)

$$\sum_{i=1}^{n} \frac{\text{Actual Risk}_i}{1.0 \times 10^{-5}} \leq 1.0$$

where:

i = carcinogenic metals considered.

If the sum of the ratios is greater than 1, then the results indicate an exceedance of the risk screening criteria.

24 When determining compliance use the maximum annual average emission rate (summed across all stacks).

The unit risk values for each pollutant are listed below:

Pollutant	Unit Risk
Arsenic	4.3E-03
Beryllium	2.4E-03
Cadmium	1.8E-03
Chromium	1.2E-02

Compute the ratio for each pollutant analyzed and list the results in the spaces provided:

	Ratio	Exceedance	Compliance
Arsenic	________		
Beryllium	________		
Cadmium	________		
Chromium	________		
Summation	________	_____	_____

Step 10: Multiple Stack Method (Optional)

This option is a special case procedure that may be helpful when (1) the facility exceeded the regulatory limits as detailed in Step 9 and (2) the facility has multiple stacks with substantially different effective release heights. This approach, when computed manually, is most practical when 1 or 2 pollutants fail the basic screening procedure (Steps 1 to 9). Only those pollutants that fail the basic screen need be addressed in this exercise.

This procedure allows the permit writer to review environmental impacts from each stack and then to sum the results to estimate total impacts. This option is conceptually the same as the basic approach and does not involve complex calculations. However, it is more time consuming and is recommended only if the basic approach (Steps 1 through 9) fails to meet the short or long-term risk criteria. The procedure is outlined below.

(A) Compute effective stack heights.

Stack No.	Stack height[25] (m)	Flow rate (m^3/sec)	Exit temp. (K)	Effective stack height (m)[26]
1	______	______	______	______
2	______	______	______	______
3	______	______	______	______

Circle the maximum and minimum effective stack heights.

(B) Determine if this multiple stacks screening procedure will likely produce less conservative results than the procedure in Steps 1 through 9.

Compute the following ratio:

$$\frac{\text{Maximum Effective Stack Height}}{\text{Minimum Effective Stack Height}} = \underline{\hspace{4cm}} > 1.25?$$

If the above ratio is greater than 1.25, proceed with the remaining steps. Otherwise, this option is less likely to significantly reduce the degree of conservatism in the screening method. If such is the case, permit writers may choose to require site-specific modeling.

(C) Determine if terrain adjustment is needed and select generic source numbers.

Select the shortest stack height and maximum terrain rise out to 5 kilometers from Step 1 and determine if the facility is in flat terrain.

Shortest stack height (m) = ______

Maximum terrain rise in meters out to 5 km = ______

---

25 Follow the procedure outlined in Step 4 of the basic screening procedure to determine the GEP for each stack. If a stack's physical height exceeds the maximum GEP, use the maximum GEP value. If a stack's physical height is less than the minimum GEP, use generic source number 11 in the subsequent steps of this analysis.

26 See Step 5 of the basic screening procedure.

$$\frac{\text{Terrain Rise (m)}}{\text{Shortest Stack Height (m)}} \times 100 = \_\_\_\_\_ (\%)$$

If the value above is greater than 10 percent, proceed directly to Step 10(D). If the ratio is less than or equal to 10 percent, identify the generic source numbers directly based on effective stack heights computed in Step 10(A). Refer to Table 3 below to identify generic source numbers.

Table 3

Effective Stack Height (m)	Generic Source No.
<10.0	1
10.0 – 14.9	2
15.0 – 19.9	3
20.0 – 24.9	4
25.0 – 30.9	5
31.0 – 41.9	6
42.0 – 52.9	7
53.0 – 64.9	8
65.0 – 112.9	9
113.0+	10
Downwash Source	11

Record below the generic source numbers identified and proceed directly to Step 10(F).

	Stack No. 1	2	3
Generic Source Numbers	____	____	____

(D) Compute terrain adjusted effective stack heights (TAESH) and select generic source numbers (for sources located in nonflat terrain).

1. Compute the terrain adjusted effective stack height for all remaining stacks using the following equation:

HE - TR = TAESH

where:

HE = effective stack height (m)

TR = maximum terrain rise for each distance range (m)

TAESH = terrain adjusted effective stack height (m).

Fill in the table below:

Terrain Adjusted Effective Stack Heights (m)[27]

	Distance range		
	0 – 0.5 km	>0.5 – 2.5 km	>2.5– 5.0 km
Stack No.	HE - TR = TAESH	HE - TR = TAESH	HE - TR = TAESH
1	___ - ___ = _____	___ - ___ = _____	___ - ___ = _____
2	___ - ___ = _____	___ - ___ = _____	___ - ___ = _____
3	___ - ___ = _____	___ - ___ = _____	___ - ___ = _____

For those stacks where the terrain rise within a distance range is greater than the effective stack height (i.e., HE - TR is less than zero), then the terrain adjusted effective stack height (TAESH) for that distance range is set equal to zero, and generic source number 1 should be used for that distance range and all subsequent distance ranges. Additionally, for all stacks with a physical stack height of less than or equal to 10 meters, used generic source 1 for all distance ranges[28]. For the remaining stacks, proceed to Step 10(D)(2).

2. For the remaining stacks, refer to the table below and, for each distance range, identify the generic source number that includes the terrain adjusted effective stack height.

---

27 Refer to Step(1) for terrain adjustment data. Note that the distance from the source to the outer radii of each range is used. For example, for the range >0.5-2.5 kilometers, the maximum terrain rise in the range 0-2.5 kilometers is used.

28 This applies to all stacks less than or equal to 10 meters regardless of the terrain classification.

Table 3

Terrain Adjusted Effective Stack Height (m)	Generic Source No.
<10.0	1
10.0 - 14.9	2
15.0 - 19.9	3
20.0 - 24.9	4
25.0 - 30.9	5
31.0 - 41.9	6
42.0 - 52.9	7
53.0 - 64.9	8
65.0 - 112.9	9
113.0+	10
Downwash Source	11

Use the values obtained from Steps 10D(1) and 10D(2) to complete the following summary worksheet:

	Generic Source Number. After Terrain Adjustment (if needed)		
Stack No.	0 - 0.5 km	>0.5 - 2.5 km	>2.5 - 5.0 km
1	___	___	___
2	___	___	___
3	___	___	___

(E) Identify maximum average hourly dispersion coefficients.

Based on the land use classification of the site (e.g., urban or rural), use either Table 4 or Table 5 to determine the appropriate dispersion coefficient for each distance range for each stack. Begin at the minimum fenceline distance indicated in Step 7(B) and record,in the worksheet which follows, the dispersion coefficient for each stack/distance range. For stacks located in facilities in flat terrain, the generic source numbers were computed in Step 10(C). For stacks located in facilities in rolling and complex terrain, the generic source numbers were computed in Step 10(D). For flat terrain applications, and for those stacks with a physical height of less than or equal to 10 meters only one generic source number will be used per stack for all distance ranges. For other applications, up to three generic source numbers may be needed per stack (i.e., a unique generic source number per distance range). In Tables 4 and 5, the dispersion coefficients for distances 6 kilometers to 20 kilometers are the same for all generic source numbers in order to conservatively represent terrain beyond 5 kilometers (past the limits of the terrain analysis).

Record the data in the table which follows.

Dispersion Coefficients by Downwind Distance[29]

Distance	Stack 1	Stack 2	Stack 3
0.20	______	______	______
0.25	______	______	______
0.30	______	______	______
0.35	______	______	______
0.40	______	______	______
0.45	______	______	______
0.50	______	______	______
0.55	______	______	______
0.60	______	______	______
0.65	______	______	______
0.70	______	______	______
0.75	______	______	______
0.80	______	______	______
0.85	______	______	______
0.90	______	______	______
0.95	______	______	______
1.00	______	______	______
1.10	______	______	______
1.20	______	______	______
1.30	______	______	______
1.40	______	______	______
1.50	______	______	______
1.60	______	______	______
1.70	______	______	______
1.80	______	______	______
1.90	______	______	______
2.00	______	______	______
2.25	______	______	______
2.50	______	______	______
2.75	______	______	______
3.00	______	______	______
4.00	______	______	______
5.00	______	______	______
6.00	______	______	______
7.00	______	______	______
8.00	______	______	______
9.00	______	______	______
10.00	______	______	______
15.00	______	______	______
20.00	______	______	______

29 Note: This procedure places all stacks at the same point, but allows for consideration of different effective stack heights. The distance to the closest boundary (extracted from Step 1) should be the closest distance to any stack.

(F) Estimate maximum hourly ambient air concentrations.

In this step, pollutant-specific emission rates are multiplied by appropriate dispersion coefficients to estimate ambient air concentrations. For each stack, emissions are multiplied by the dispersion coefficients selected in Step 10(E) and summed across all stacks to estimate ambient air concentrations at various distances from the facility. From these summed concentrations, the maximum hourly ambient air concentration is selected. First, select the maximum emission rate the pollutant under study[30]. Record these data in the spaces provided below.

Maximum Annual Emission Rates[31]

Pollutant	Stack 1	Stack 2	Stack 3
________	______	______	______
________	______	______	______

For each pollutant, complete the following table and select the highest hourly concentration from the summation column at the far right of the table.

30 Recall that it is recommended that this analysis be performed manually for only one or two pollutants. The pollutants chosen for this analysis should be those that show the most significant exceedances of the risk threshold.

31 Refer to Step 1 of the basic screening procedure. Note that at this point in the screening procedure, annual emissions are used to represent hourly average emission rates. These values will be adjusted by the long term/short term ratio to estimate annual average concentrations.

Maximum Hourly Ambient Air Concentration

Pollutant ____________

Total distance (km)	Stack 1 ER x DC = C	Stack 2 ER x DC = C	Stack 3 ER x DC = C	Total concentration
0.20	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.25	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.30	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.35	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0 40	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0 45	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0 50	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.55	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.60	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.65	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.70	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.75	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.80	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.85	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.90	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
0.95	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
1.00	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
1.10	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
1.20	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
1.30	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
1.40	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______
1.50	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______

ER = Annual average emission rate
DC = Hourly dispersion coefficient (from previous step).
C = Estimated maximum hourly ambient air concentration

Note: The emission rates for maximum 3-min HCl concentrations are scaled up in Step 10(l) to account for higher short-term emission rates.

1.60	______ x ______ = ______	______ x ______ = ______	______ x ______ = ______	______

Maximum Hourly Ambient Air Concentration

Pollutant ____________

Total distance (km)	Stack 1 ER x DC = C	Stack 2 ER x DC = C	Stack 3 ER x DC = C	Total concentration
1.70	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
1.80	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
1.90	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
2.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
2.25	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
2.50	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
2.75	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
3.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
4.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
5.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
6.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
7.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
8.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
9.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
10.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
15.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
20.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____

ER = Annual average emission rate
DC = Hourly dispersion coefficient (from previous step).
C = Estimated maximum hourly ambient air concentration

Note: The emission rates for maximum 3-min HCl concentrations are scaled up in Step 10(l) to account for higher short-term emission rates.

Maximum Hourly Ambient Air Concentration

Pollutant ____________

Total distance (km)	Stack 1 ER x DC = C	Stack 2 ER x DC = C	Stack 3 ER x DC = C	Total concentration
0.20	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.25	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.30	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.35	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.40	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.45	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.50	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.55	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.60	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.65	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.70	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.75	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.80	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.85	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.90	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
0.95	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
1.00	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
1.10	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
1.20	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
1.30	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
1.40	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________
1.50	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________

ER = Annual average emission rate
DC = Hourly dispersion coefficient (from previous step).
C = Estimated maximum hourly ambient air concentration

Note: The emission rates for maximum 3-min HCl concentrations are scaled up in Step 10(l) to account for higher short-term emission rates.

1.60	_______ x _______ = _______	_______ x _______ = _______	_______ x _______ = _______	____________

Maximum Hourly Ambient Air Concentration

Pollutant ____________

Total distance (km)	Stack 1 ER x DC = C	Stack 2 ER x DC = C	Stack 3 ER x DC = C	Total concentration
1.70	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
1.80	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
1.90	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
2.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
2.25	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
2.50	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
2.75	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
3.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
4.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
5.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
6.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
7.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
8.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
9.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
10.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
15.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____
20.00	____ x ____ = ____	____ x ____ = ____	____ x ____ = ____	____

ER = Annual average emission rate
DC = Hourly dispersion coefficient (from previous step).
C = Estimated maximum hourly ambient air concentration

Note: The emission rates for maximum 3-min HCl concentrations are scaled up in Step 10(l) to account for higher short-term emission rates.

Record the maximum hourly air concentration for each pollutant analyzed in the table below:

Pollutant	Maximum Hourly Air Concentration
________	________
________	________

(G) Determine the complex/noncomplex designation for each stack.

For each stack subtract the maximum terrain rise out to 5 kilometers from the physical stack height and designate the stack as either complex or noncomplex. Use the following criteria to make this determination:

- If the stack height minus the maximum terrain rise (out to 5 kilometers) is greater than zero, then assign the stack a noncomplex designation.
- If the stack height minus the maximum terrain rise (out to 5 kilometers) is less than or equal to zero, then assign the stack a complex designation.

All stacks less than 10 meters in physical height are assigned a noncomplex designation.

Perform the following computation for each stack and record the information in the spaces provided. Check in the spaces provided whether the stack designation is complex or noncomplex.

Stack No.		Complex	Noncomplex
1	Stack Height (m) - Max. Terrain Rise (m) = ____(m)	____	____
2	Stack Height (m) - Max. Terrain Rise (m) = ____(m)	____	____
3	Stack Height (m) - Max. Terrain Rise (m) = ____(m)	____	____

(H) Identify Long-Term/Short Term Ratios.

Extract the long-term/short-term ratios for each stack by referring to Table 6 (which for convenience is repeated below). Generic source numbers (from Steps 10(C) or 10(D), urban/rural designation (from Step 6), and complex or noncomplex terrain designations (from Step 10(G)) are used to select the appropriate scaling factor to convert short-term maximum concentrations to estimates of annual average concentrations. The following table must be used to complete this step.

Table 6
95th Percentile of Long-Term/Short-Term Ratios

Noncomplex Terrain			Complex Terrain		
Source	Urban	Rural	Source	Urban	Rural
1	0.019	0.014	1	0.020	0.053
2	0.033	0.019	2	0.020	0.053
3	0.031	0.018	3	0.030	0.057
4	0.029	0.017	4	0.051	0.047
5	0.028	0.017	5	0.067	0.039
6	0.028	0.017	6	0.059	0.034
7	0.031	0.015	7	0.036	0.031
8	0.030	0.013	8	0.026	0.024
9	0.029	0.011	9	0.026	0.024
10	0.029	0.008	10	0.017	0.013
11	0.018	0.015	11	0.020	0.053

Complete the following table.

Stack No.	Generic Source No. Steps 10 (C or D)			Long-term/short-term ratio (from Table 5)[32]		
	Distance ranges (km)			Distance ranges (km)		
	0-0.5	>0.5-2.5	>2.5-5.0	0-0.5	>0.5-2.5	>2.5-5.0
1	___	___	___	______	______	______
2	___	___	___	______	______	______
3	___	___	___	______	______	______

32 If any stack (excluding generic stack numbers 1 and 11) in Step 10(D) shows a negative terrain adjusted stack height, use the complex terrain long-term/short-term ratios. Note that Step 6 defines whether urban or rural ratios should be used.

Select the highest ratio among the set of stacks.[33] Use this ratio in Step 10(I) to estimate maximum ambient air concentrations.

(I) Estimate maximum annual and 3-minute average concentrations for each pollutant by completing the following table, where:

C = Maximum total hourly ambient air concentration for pollutant "N" ($\mu g/m^3$)

C_A = Maximum annual average air concentration for pollutant "N" ($\mu g/m^3$)

$C_{3\text{-}Min}$ = Maximum 3-minute average concentration ($\mu g/m^3$)

R = Long-term/short-term ratio

ER_{3N}/ER_{AN} = The highest ratio (across all stacks) of the maximum 3-minute emission rate divided by the annual average emission rate.

Pollutant	Max hourly conc.[34] C ($\mu g/m^3$)	Annual averages $C \times R = C_A$ ($\mu g/m^3$)	3-Min averages. $C \times 1.64 \times \frac{ER_{3N}}{ER_{AN}} = C_{3\text{-}Min}$ ($\mu g/m^3$)
______	______	______ x ______ = ______	
______	______	______ x ______ = ______	
______	______	______ x ______ = ______	______ x 1.64 x ______ = ______

(J) Determine compliance with regulatory requirements.

1. For the noncarcinogenic compounds (antimony, barium, lead, mercury, silver, thallium, and hydrogen chloride), use the following equation to determine compliance:

$$\frac{\text{Annual Ambient Air Concentration } (\mu g/m^3)^{35}}{\text{RAC } (\mu g/m^3)} \leq 1.0.$$

33 As an option, the user could identify the stack with the highest ratio for each distance range (rather than the absolute highest). In this case, extra sheets would be needed to show estimated annual average concentrations from each stack by multiplying emission rate times maximum hourly dispersion coefficient times maximum long-term/one-hour ratio for applicable distance range. Then sum across all stacks for each downwind distance.

34 From Step 10(F).

35 From Step 10(I). Use the 3-minute average ambient concentration to evaluate compliance on a 3-minute basis.

If the ratio for any pollutant is greater than 1, then the results indicate an exceedance of the regulatory risk criteria.

The RACs for each pollutant are listed below:

Pollutant	RAC
Antimony	0.3
Barium	50
Lead	0.09
Mercury	0.3
Silver	3
Thallium	0.3
HCl (3 minute)	150
(annual)	7

Compute the ratio for each pollutant analyzed and list the results in the spaces provided:

Pollutant	Ratio	Exceedance	Compliance
________	________	_____	_____
________	________	_____	_____
________ (3 minute)	________	_____	_____

2. For the carcinogenic compounds (arsenic, beryllium, cadmium, and chromium), use the following equation to determine compliance:

Actual Risk = Annual Ambient Air Concentration[36] (g/sec) x Unit Risk ($m^3/\mu g$)

$$\sum_{i=1}^{n} \frac{\text{Actual Risk}_i}{1.0 \times 10^{-5}} \leq 1.0$$

where i = carcinogenic metals considered.

36 From Step 10(I).

Table 2
Plume Rise Values (m) vs. Stack Parameters

Flow rate* (m3/sec)	Exhaust temperature (K)										
	<325	325-349	350-399	400-449	450-499	500-599	600-699	700-799	800-999	1000 1499	>1499
<0.5	0	0	0	1	1	1	1	1	1	1	1
0.5-0.9	1	1	1	1	1	1	2	2	2	3	2
1.0-1.9	1	1	1	2	2	2	3	3	3	4	4
2.0-2.9	1	1	2	3	4	4	5	5	6	6	7
3.0-3.9	2	2	3	4	5	6	7	7	8	8	9
4.0-4.9	2	2	3	5	6	7	8	9	10	10	11
5.0-7.4	3	3	4	6	7	8	10	11	11	12	13
7.5-9.9	3	4	5	8	10	11	13	14	15	17	18
10.0-12.4	4	5	7	10	12	14	16	18	19	21	23
12.5-14.9	5	5	8	12	14	16	19	21	22	24	27
15.0-19.9	6	6	9	13	16	19	22	24	26	28	31
20.0-24.9	7	8	11	17	20	23	27	30	32	35	38
25.0-29.9	8	9	13	20	24	27	32	35	38	41	44
30.0-34.9	9	10	15	22	27	31	37	40	42	45	49
35.0-39.9	10	12	17	25	31	35	41	44	46	50	54
40.0-49.9	11	13	19	28	34	39	44	48	50	54	58
50.0-59.9	14	15	22	33	40	44	50	55	57	61	66
60.0-69.9	16	18	26	38	45	50	56	61	64	68	74
>69.9	18	20	29	42	49	54	62	67	70	75	81

(1) Using the given stack exit flow rate and gas temperature, find the corresponding plume rise value from the above table.

(2) Add the physical stack height to the corresponding plume rise values [effective stack height = physical stack height + plume rise].

*Plume rise is a function of buoyancy and momentum which are in turn functions of flow rate, not simply exit velocity. Flow Rate is defined as the inner cross-sectional area of the stack multiplied by the exit velocity of the stack gases.

(C) Go to the first column of Table 3 and identify the range of effective stack heights that includes the effective stack height estimated in Step 5(B). Identify the generic source number that corresponds to this range. For all facilities where the physical height of the worst-case stack is less than the minimum GEP, generic source number 11 should be used.

Table 3

Effective Stack Height (m)	Generic Source No.
<10.0	1
10.0 - 14.9	2
15.0 - 19.9	3
20.0 - 24.9	4
25.0 - 30.9	5
31.0 - 41.9	6
42.0 - 52.9	7
53.0 - 64.9	8
65.0 - 112.9	9
113.0+	10
Downwash Source	11

(D) The generic source number (without terrain adjustment) identified by the preceding step will be used in subsequent steps of this procedure. Record the generic source number below.

Generic source number = ____.

(E) If the source is located in flat terrain [12], if the physical stack height of the worst case stack is less than or equal to 10 meters[13], or if the generic source number identified in Step 5(D) above is 1 or 11 (regardless of terrain classification) then the effective stack height will not be adjusted to account for terrain. If any of these conditions are met, use the generic source number determined in Step 5(D) and proceed directly to Step 6. Otherwise, continue through the remainder of this step.

---

12 Flat terrain is defined in this report as follows: If the maximum terrain rise within 5 kilometers of the facility is less than 10 percent of the physical stack height of the worst-case stack, the location is considered to be flat and terrain adjustment factors will not be considered.

13 This condition applies regardless of terrain characteristics.

Use the following calculation to identify flat areas.

$$\frac{\text{Terrain Rise[14] (m)}}{\text{Physical Worst-Case Stack Height (m)}} \times 100 = \_\_\_\_\_\_ (\%)$$

If the value is less than 10 percent then the source is in flat terrain. Use the generic source number recorded in Step 5(D) and proceed directly to Step 6.

(F) For those situations where the conditions of Step 5(E) do not apply, the effective stack height must be adjusted for terrain. The terrain adjusted effective stack height (TAESH) is computed by subtracting the terrain rise for each distance range from the effective stack height (identified in Step 5(B)). Complete the following table to estimate the terrain adjusted effective stack height.:

Distance Range (m)	Effective Stack Height (m)[15]	-	Maximum Terrain Rise (m)[16]	=	TAESH(m)
0 - 0.5 km	________	-	________ max. terrain rise (0-0.5 km)	=	________
>0.5- 2.5 km	________	-	________ max. terrain rise (0-2.5 km)	=	________
>2.5- 5.0 km	________	-	________ max. terrain rise (0-5.0 km)	=	________

If the terrain rise for any of the distance ranges is greater than the effective stack height, set the terrain adjusted effective stack height (TAESH) equal to zero and use generic source number 1 for that distance range.

---

14 Maximum terrain rise within 5 kilometers of the facility.

15 In this analysis, the effective stack height is considered to be constant across each distance range. The effective stack height was determined in Step 5(B). In most cases, however, the maximum terrain rise will vary for each distance range.

16 The distance ranges used to identify maximum terrain rise are 0-0.5, 0-2.5, and 0-5.0. These ranges correspond to the data requirements of WORKSHEET 1. Consideration of the maximum terrain rise from the release point to the outer edge of each distance range must be specified to ensure that dispersion in complex terrain situations are conservatively treated. This procedure is particularly needed for those situations where the maximum terrain rise is lower in the outer distance ranges than in the distance ranges closer to the source.

(G) Table 3 (which is repeated below for convenience) displays ranges of effective release heights for the 11 generic sources. For each distance range, identify the generic source that contains the terrain adjusted effective stack height (TAESH). Record this information in the space provided. These generic source numbers will be used in the subsequent steps of this analysis (in lieu of the generic source initially determined in Step 5(D)).

Table 3

Terrain adjusted effective stack height (m)	Generic source No.
<10.0	1
10.0 – 14.9	2
15.0 – 19.9	3
20.0 – 24.9	4
25.0 – 30.9	5
31.0 – 41.9	6
42.0 – 52.9	7
53.0 – 64.9	8
65.0 – 112.9	9
113.0+	10
Downwash Source	11

Record the generic source numbers in the following spaces:

Distance Range (km)	Generic source No. (after terrain adjustment)
0 – 0.5	________
>0.5 – 2.5	________
>2.5 – 5.0	________

The dispersion coefficients estimated in this screening procedure are a function not only of generic source number, but also urban/rural classification. Step 6 present guidance for estimating urban/rural classification.

Step 6: Classify the Site as Urban or Rural

To utilize this screening procedure, the user must classify the land area within a 3-kilometer radius of the facility as either urban or rural. This classification can be made using the simplified procedure shown in Appendix I of the Metals Guidance Document. The steps for this classification procedure are presented below. The user should document the classification procedure in the spaces provided:

1. Determine the percentage of urban land use types (as defined in Appendix I) that fall within 3 kilometers of the facility.

Method Used to Estimate Percent Urban Land Use (check applicable space)	Visual	Planimeter
	_______	_______

2. Determine the percentage of the land use that is urban by multiplying the ratio of the urban area to the area of the 3-kilometer circle by 100. The remaining percentage is considered rural.

Estimated Percentages (check applicable spaces)	Urban	Rural
	_______	_______

3. If the urban land use percentage is less than or equal to 30 percent based on a visual estimate (or 50 percent if based on a planimeter), use the rural tables in Tab B.

   If the urban land use percentage (as defined in Appendix I) is greater than 30 percent (or 50 percent based on planimeter measurements), the most conservative (lower) value between the urban and rural screening tables (Tables 3 and 4) should be used, or the standard Auer land use technique should be applied (Auer 1978, EPA 1986 Guideline on Air Quality Models).

Classification (check applicable space)	Urban	Rural
	_______	_______

Step 7: Identify Maximum Dispersion Coefficients

(A) Select dispersion coefficients.

Based on the results of Step 6, select either Table 4 (urban) or Table 5 (rural) to be used to identify dispersion coefficients.

Table 4
ISCST Predicted Maximum Concentrations (μg/m³)*
for Hazardous Waste Incinerators Using Urban Conditions

DISTANCE (KM)	Generic Source #1 (<10 M)	Generic Source #2 (10 M)	Generic Source #3 (15 M)	Generic Source #4 (20 M)	Generic Source #5 (25 M)	Generic Source #6 (31 M)	Generic Source #7 (42 M)	Generic Source #8 (53 M)	Generic Source #9 (65 M)	Generic Source #10 (113 M)	Generic Source #11 (Downwash)
0.20	680.1	517.5	368.7	268.7	168.5	129.8	63.4	30.1	18.4	1.6	662.3
0.25	521.9	418.2	303.7	232.6	163.0	124.2	67.6	38.5	19.8	3.2	500.0
0.30	407.7	351.7	256.2	199.0	147.0	118.3	63.5	41.5	25.0	4.2	389.3
0.35	328.2	304.2	221.6	172.7	130.2	107.9	60.8	40.5	27.3	5.4	311.9
0.40	268.5	268.5	195.6	152.5	115.7	97.1	59.6	37.8	27.4	5.8	268.5
0.45	240.8	240.7	175.4	136.7	103.9	87.6	56.6	37.2	26.3	5.8	240.8
0.50	218.5	218.5	159.2	124.1	94.4	79.7	52.9	36.7	24.7	5.8	218.5
0.55	200.3	200.3	145.9	113.8	86.5	73.1	49.2	35.4	24.5	6.6	200.3
0.60	185.1	185.1	134.9	105.1	80.0	67.6	45.8	33.8	24.3	7.1	185.1
0.65	172.2	172.2	125.5	97.8	74.4	62.9	42.7	32.0	23.7	7.4	172.2
0.70	161.2	161.2	117.4	91.6	69.6	58.9	40.1	30.2	22.9	7.5	161.2
0.75	151.6	151.6	110.5	86.1	65.5	55.4	37.7	28.6	22.0	7.5	151.6
0.80	143.2	143.2	104.4	81.4	61.9	52.3	35.6	27.1	21.1	7.4	143.2
0.85	135.8	135.8	99.0	77.2	58.7	49.6	33.8	25.7	20.2	7.2	135.8
0.90	129.2	129.2	94.2	73.4	55.8	47.2	32.1	24.5	19.3	7.0	129.2
0.95	123.3	123.3	89.9	70.1	53.3	45.0	30.7	23.4	18.5	6.8	123.3
1.00	118.0	118.0	86.0	67.0	51.0	43.1	29.4	22.4	17.7	6.5	118.0
1.10	108.8	108.8	79.3	61.8	47.0	39.7	27.1	20.6	16.4	6.5	108.8
1.20	101.1	101.1	73.7	57.4	43.7	36.9	25.2	19.2	15.2	6.4	101.1
1.30	94.6	94.6	68.9	53.7	40.9	34.5	23.5	18.0	14.2	6.3	94.6
1.40	89.0	89.0	64.8	50.6	38.5	32.5	22.1	16.9	13.4	6.1	89.0
1.50	84.1	84.1	61.3	47.8	36.3	30.7	20.9	16.0	12.7	5.9	84.1
1.60	79.8	79.8	58.2	45.4	34.5	29.2	19.9	15.2	12.0	5.6	79.8
1.70	76.0	76.0	55.4	43.2	32.9	27.8	18.9	14.4	11.4	5.4	76.0
1.80	72.7	72.7	53.0	41.3	31.4	26.5	18.1	13.8	10.9	5.2	72.7
1.90	69.6	69.6	50.7	39.6	30.1	25.4	17.3	13.2	10.5	5.0	69.6
2.00	66.9	66.9	48.8	38.0	28.9	24.4	16.7	12.7	10.1	4.8	66.9
2.25	61.1	61.1	44.5	34.7	26.4	22.3	15.2	11.6	9.2	4.4	61.1
2.50	56.4	56.4	41.1	32.1	24.4	20.6	14.0	10.7	8.5	4.1	56.4
2.75	52.6	52.6	38.3	29.9	22.7	19.2	13.1	10.0	7.9	3.8	52.6
3.00	49.3	49.3	35.9	28.0	21.3	18.0	12.3	9.4	7.4	3.6	49.3
4.00	40.2	40.2	29.3	22.8	17.4	14.7	10.0	7.6	6.1	2.9	40.2
5.00	34.5	34.5	25.2	19.6	14.9	12.6	8.6	6.6	5.2	2.5	34.5
6.00	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7
7.00	27.8	27.8	27.8	27.8	27.8	27.8	27.8	27.8	27.8	27.8	27.8
8.00	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5
9.00	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
10.00	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3
15.00	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
20.00	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0

* BASED ON A 1 GRAM/SECOND EMISSION RATE

Table 5
ISCST Predicted Maximum Concentrations ($\mu g/m^3$)*
for Hazardous Waste Incinerators Using Rural Conditions

DISTANCE (KM)	Generic Source #1 (<10 M)	Generic Source #2 (10 M)	Generic Source #3 (15 M)	Generic Source #4 (20 M)	Generic Source #5 (25 M)	Generic Source #6 (31 M)	Generic Source #7 (42 M)	Generic Source #8 (53 M)	Generic Source #9 (65 M)	Generic Source #10 (113 M)	Generic Source #11 (Downwash)
0.20	1771.1	670.3	308.6	176.8	102.8	76.5	28.0	10.1	3.5	0.0	1350.8
0.25	1310.6	678.4	316.9	183.6	104.6	71.8	38.0	17.6	7.9	0.2	1227.3
0.30	1002.3	629.2	303.4	199.1	100.4	75.0	39.7	24.0	12.6	0.8	1119.3
0.35	798.4	569.6	282.3	200.7	117.0	71.1	36.3	25.9	16.8	1.9	1023.8
0.40	656.9	516.5	278.7	194.4	125.2	82.7	35.2	24.6	18.1	3.1	938.9
0.45	621.5	471.1	277.6	184.3	127.5	89.7	35.6	21.7	17.6	4.3	851.8
0.50	633.5	432.4	272.0	172.7	125.7	92.9	34.4	21.6	15.9	5.5	787.8
0.55	630.1	399.2	263.8	168.0	121.6	93.3	38.6	22.1	13.6	6.5	730.6
0.60	616.6	370.4	254.0	169.1	116.2	91.8	42.6	21.7	14.3	6.7	679.4
0.65	596.7	345.4	243.6	168.1	110.3	89.2	45.3	20.9	14.7	6.4	633.4
0.70	573.2	323.4	232.9	165.6	104.5	85.8	47.0	23.3	14.6	5.9	592.0
0.75	546.9	304.0	222.3	162.0	98.8	82.2	47.7	25.5	14.3	5.5	554.6
0.80	520.9	286.8	212.1	157.7	98.8	78.5	47.8	27.1	13.8	5.1	522.1
0.85	495.7	271.5	202.4	153.0	99.0	74.9	47.4	28.3	15.0	4.7	491.8
0.90	471.5	257.8	193.3	148.1	98.6	71.4	46.6	29.1	16.3	4.5	464.2
0.95	448.5	245.4	184.7	143.1	97.6	72.3	45.6	29.6	17.3	4.2	438.9
1.00	426.8	234.2	176.8	138.1	96.3	72.6	44.4	29.8	18.2	4.0	415.8
1.10	387.5	214.7	162.5	128.2	91.9	71.1	41.8	29.5	19.3	3.9	375.0
1.20	353.1	198.4	150.3	119.3	87.4	69.1	39.1	28.6	19.8	4.1	340.3
1.30	323.0	189.6	139.9	111.5	82.9	66.7	36.6	27.5	19.8	4.2	310.4
1.40	296.6	182.2	130.8	104.5	78.7	64.2	34.3	26.2	19.5	4.2	284.6
1.50	273.3	174.6	122.9	98.3	74.7	61.6	32.3	24.9	19.0	4.2	262.0
1.60	252.7	167.0	115.9	92.8	71.0	59.1	31.8	23.6	18.4	4.2	242.2
1.70	234.5	159.6	109.7	87.9	67.6	56.7	31.6	22.5	17.7	4.3	224.7
1.80	218.3	152.4	104.1	83.5	64.4	54.3	31.3	21.4	17.0	4.5	211.9
1.90	203.7	145.6	99.1	79.5	61.5	52.1	30.9	20.4	16.3	4.8	198.4
2.00	190.7	139.1	94.6	75.9	58.8	50.0	30.4	19.5	15.7	5.1	186.3
2.25	164.4	124.5	85.1	68.3	53.0	45.4	28.9	18.1	14.2	5.4	160.8
2.50	143.7	112.1	77.3	62.1	48.2	41.4	27.2	17.9	12.9	5.5	140.7
2.75	127.0	101.5	70.9	56.9	44.3	38.1	25.6	17.5	11.8	5.4	124.5
3.00	113.4	92.4	65.6	52.6	40.9	35.2	24.0	17.0	11.2	5.2	112.5
4.00	78.8	67.3	50.6	40.6	31.6	27.2	19.0	14.3	10.4	4.3	78.3
5.00	59.1	54.6	41.4	33.2	25.8	22.2	15.6	12.0	9.3	3.5	58.8
6.00	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7
7.00	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4
8.00	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
9.00	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2
10.00	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
15.00	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
20.00	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9

* BASED ON A 1 GRAM/SECOND EMISSION RATE