This guidance document is advisory in nature but is binding on an agency until amended by such agency. A guidance document does not include internal procedural documents that only affect the internal operations of the agency and does not impose additional requirements or penalties on regulated parties or include confidential information or rules and regulations made in accordance with the Administrative Procedure Act. If you believe that this guidance document imposes additional requirements or penalties on regulated parties, you may request a review of the document.

03-151 November 2003

ENVIRONMENTAL GUIDANCE DOCUMENT

AIR EMISSIONS GUIDANCE FOR PETROLEUM REMEDIATION SITES

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IMPORTANT NOTICE

Implementation of a remedial system without an AS or SVE assessment or with an assessment not first approved by the Department's Petroleum Remediation Section (excluding those constructed under the Pay-For-Performance process) may result in reimbursement reduction of up to 100 per cent. Furthermore, construction and operation of a remedial system exceeding permit threshold levels established in Title 129 – Nebraska Air Quality Regulations is subject to enforcement and possible penalties by the Department's Air Quality Division, including those systems constructed and operated under the Pay-For-Performance Process.

LIST OF ACRONYMS AND CONTACTS

AS	Air Stripper
AST	Aboveground Storage Tank
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
HAPs	Hazardous Air Pollutants
ISCST Model	Industrial Source, Complex, Short Term Model
LUST	Leaking Underground Storage Tank
M&I	Municipal and Industrial
MTBE	Methyl Tertiary-Butyl Ether
NDEQ	Nebraska Department of Environmental Quality
NPDES	National Pollutant Discharge Elimination System
PFP	Pay-For-Performance
PR	Petroleum Remediation
PTE	Potential To Emit
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
RP	Responsible Party
SVE[a]	Soil Vapor Extraction
tpy	Tons per year
TV	Total Volatile
VC	Volatile Compounds
VOCs	Volatile Organic Compounds
UST	Underground Storage Tank

Air Quality Construction Permit Team	(402) 471-2189
Petroleum Remediation Section	(402) 471-2186
NPDES Permit Unit, Wastewater Section	(402) 471-4220

[a] For the purposes of this protocol, the term SVE includes any remedial technology (e.g., bioventing, mechanical) that extracts petroleum vapors from the subsurface and emits them to the ambient air.

SECTION 1 INTRODUCTION

The Nebraska Department of Environmental Quality (hereafter referred to as Department or NDEQ) developed this guidance in response to concerns regarding potential exposure risks from the remediation of petroleum contaminated soil and ground water through the use of air strippers (AS) and/or soil vapor extraction (SVE[a]) systems. It is applicable to any petroleum release remediation site, including underground storage tank (UST), aboveground storage tank (AST), pipeline, and surface spill contamination sites. Unless approved by the Department, this guidance is not to be used to assess exposure risks at hazardous substance/waste remediation sites (e.g., CERCLA, RCRA, etc.). In addition, it must not be used to evaluate risks for routine emissions associated with stationary sources (e.g., factories, industries, etc**.). Emergency situations, as declared by the Department Director, are not subject to this guidance until the emergency condition has been mitigated.**

This document is guidance only and should not be construed as being regulation. For those areas of this guidance document that are required by statute or regulation (i.e., the Petroleum Products and Hazardous Substances Storage and Handling Act §81-15,124(2), Title 126 – Rules and Regulations Pertaining To The Management of Wastes, and NDEQ Title 129 - Nebraska Air Quality Regulations), the document language will indicate that the actions ***must*** be conducted. For those areas that are recommended, the document language will indicate that the actions are "recommended" or "should" be conducted. For clarification purposes, the emission assessments, both permitting and risk, ***must*** be completed. The manner in which they are completed is left to the discretion of the responsible party (RP) or their representative, and in the case of the Pay for Performance (PFP) process, to the discretion of the PFP contractor.

The AS portion of this document was developed in accordance with EPA document "AIR/SUPERFUND TECHNICAL GUIDANCE STUDY SERIES: Estimation of Air Impacts for Air Stripping of Contaminated Water" (EPA-450/1-91-02). The Department's Air Quality Construction Permitting Team and Petroleum Remediation (PR) Section developed the SVE portion of this document.

Regulatory emission rates for hazardous air pollutants (HAPs) (Appendix C) are defined in NDEQ Title 129. Construction and Operation Permit information and calculation methods for HAPs are described in Section 2 of this document (process summarized in Appendix A). If a petroleum remedial system (i.e., AS, SVE, combined AS/SVE) is designed, operated, and modified as described immediately below, it is approved and will not require a permit.

- Design and operate the system(s) in such a manner as **not** to exceed contaminant concentration levels that would necessitate the need for a construction and/or operation permit (see Section 2B).
- Collect samples in the time periods established in the appropriate subsections of Data Collection and Sample Analysis Procedures (Section 2C) utilizing the identified analysis methods.

[a] For the purposes of this protocol, the term SVE includes any remedial technology (e.g., bioventing, mechanical) that extracts petroleum vapors from the subsurface and emits them to the ambient air.

- Submit all air emission sampling data in accordance with Section 4, Reporting Procedures. For remediation projects conducted under the PFP Process, submit all air emission sampling data as established in the Department's contract.

For carcinogenic volatile organic compounds (VOCs) only, an air emission exposure risk to the public ***must*** be calculated based upon a $1x10^{-6}$ cancer risk (Section 3). If the emissions pose a cancer risk of $1x10^{-6}$ or less, then the system is approved for purposes of cancer risk (process summarized in Appendix A). If individual or combined HAPs and/or the cancer risk are greater than $1x10^{-6}$, then it ***must*** be reported to the NDEQ PR Section project manager, the remedial system ***must*** be redesigned, and best engineering practices (i.e., emissions control/treatment or system design modifications) are used to ensure that the cancer risk is not exceeded. For sites utilizing both AS and SVE systems, or more than one AS or SVE system, the total cancer risk is additive. That is, the cancer risk for each system ***must*** be determined individually, then summed, and averaged for all sampling events. If the cumulative risk is greater than $1x10^{-6}$, then measures must be taken as described above. If a petroleum remedial system (i.e., AS, SVE, combined AS/SVE) is designed, operated, and modified as described immediately below, it is approved.

- Design and operate the system(s) in such a manner that total VOC emissions do **not** exceed a cancer risk of $1x10^{-6}$ (see Section 3).
- Collect samples in the time periods established in the appropriate subsections of Data Collection and Sample Analysis Procedures (Section 3B) utilizing the identified analysis methods.
- Submit all air emission sampling data in accordance with Section 4, Reporting Procedures. For remediation projects conducted under the Pay For Performance (PFP) Program, submit all air emission sampling data as established in the Department's contract.

Remedial actions taken in response to cleanup of petroleum releases from aboveground and underground storage tanks are eligible for reimbursement consideration under NDEQ Title 200 – Rules and Regulations for Petroleum Release Remedial Action Reimbursement Fund. Both the Department's Air Quality and Water Quality Divisions consider the guidance and reporting procedures outlined herein as approved activities. If the assessment is completed in accordance with this approved guidance, reasonable costs associated with such actions are eligible for Title 200 reimbursement consideration.

Implementation of a remedial system without an AS or SVE assessment or with an assessment not first approved by the Department's Petroleum Remediation Section (excluding those constructed under the Pay-For-Performance process) may result in reimbursement reduction of up to 100 per cent. Furthermore, construction and operation of a remedial system exceeding permit threshold levels established in Title 129 – Nebraska Air Quality Regulations is subject to enforcement and possible penalties by the Department's Air Quality Division, including those systems constructed and operated under the Pay-For-Performance Process.

Utilizing the standard guidance and forms provided herein reduces reviewing time for NDEQ personnel. Should the RP or their consultant wish to propose alternative methodologies to evaluate air emissions, it ***must*** be done by submitting the proposal, **in detail and in writing**, for review to the PR Section as part of the Remedial Action Plan (RAP) for the site. At a minimum, it must be justified that any emission alternative methodology will provide better data than the

methodologies provided and, at the same time, be of cost benefit. The Department will review alternative proposals on a case-by-case basis.

SECTION 2 PERMIT REQUIREMENTS AND CALCULATION METHODS

A. Introduction:

Pursuant to the requirements of Title 129, construction and operating permits are needed for any remediation system having Potential To Emit (PTE) contaminants at or above the levels specified below (see Appendix A flowchart).

B. Permit Requirements:

As defined in Title 129, construction and operating permits will be needed if:

1. The PTE is 40 or more tons per year of volatile organic compounds (VOCs); or
2. The PTE is 2.5 or more tons per year of any HAP (Appendix C), including, but not limited to, Benzene, Toluene, Ethylbenzene, or Xylenes (BTEX), Methyl Tertiary-Butyl Ether (MTBE), n-Hexane or an aggregate of 10 or more tons per year of two or more regulated HAPs.

If the above threshold amounts are exceeded, permits are required; therefore the system(s) ***must*** be designed and operated in such a manner as to not exceed these threshold amounts.

C. Data Collection and Sample Analysis Procedures:

1. Data Collection: It is strongly recommended that appropriate information to predict operational needs during system operation be collected during or as part of a ground water pump test and/or SVE pilot test when conducted.

2. Sample Analysis: To determine the PTE tonnage, as described in Section 2B above, samples ***must*** be analyzed using methods approved by the NDEQ. The following is a list of approved methods for BTEX, MTBE, n-Hexane, Volatile Compounds (VC), and Total Volatiles (TV):

- BTEX, MTBE, and n-Hexane (Water)[a]: Methods OA-1 or 8260 are acceptable,
- BTEX, MTBE, and n-Hexane (Air): Method 18,
- VC (Water)[a]: Methods OA-1 or 8260 are acceptable,
- TV (Air)[b]: Method 25, Method 25A or other methods approved by the Air Quality Construction Permit Team for air samples.

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[a] The National Pollutant Discharge Elimination System (NPDES) program requires that water samples be analyzed using methods approved in 40 CFR Part 136 (Methods 602, 624, and 1624). Contact the NPDES Permits Unit, Wastewater Section, at (402/471-4220) for additional information.

[b] Methods 25 and 25A, air-sampling methods found at 40 CFR 60, Appendix A, will provide a single concentration value that represents the total concentration of gaseous organics within the sample. The NDEQ will allow the use of this value for determining if the 10.0 tpy HAP threshold is exceeded. This value is accepted because it would represent an overestimation of the concentration of HAPs being emitted. If the 10.0 tpy threshold is exceeded, the HAP emissions should be recalculated using Method 18 results.

Address any questions regarding interpretation of the Title 129 regulations to the Department's Air Quality Permit Section at (402) 471-2189. Any questions regarding air analysis method approval should be directed to the Air Quality Construction Permit Team. Questions regarding water analysis method approval should be directed to the PR Section.

3. Analysis Requirements: The sample analysis requirements will vary depending upon the product released and/or the contaminants present at the site. The following is being provided as guidance on adjusting the VC and TV analysis:

- VC/TV samples will not be necessary at fuel oil release sites. The term "fuel oil" refers to kerosene, #1 and heavier diesel, JP-8, and heavier petroleum products;
- VC/TV samples are required at gasoline and JP-4 release sites; and,
- VC/TV samples are necessary for all sites that are adjacent to, overlie, or are commingled with another source of volatile organic contamination (e.g., a Superfund site).

D. Permit Emission Calculations:

Several methods can be used to calculate the quantity of air emissions for operational purposes. It is the responsibility of the RP/consultant, in accordance with Title 129, Chapter 17, to choose a method, which will provide an accurate estimate of potential emission quantities. An example method is provided below. The chosen method and associated calculations ***must*** be provided as part of the RAP required by the PR Section.

If the proposed remediation system uses more than one remediation technology (e.g., AS and SVE) which will emit pollutants to the atmosphere, then the permit emission calculation for each system ***must*** be derived individually and the sum of the results calculated to determine the total tonnage of pollutant(s) being emitted. In addition, the calculation ***must*** be completed for each pollutant or combination of pollutants as per Section 2B above.

The following emission calculation procedures are provided to assess the emissions from petroleum release AS and SVE systems. These procedures are based on data collected from a pump test and/or SVE pilot test. If these tests were not conducted, the potential emissions from this remediation project will have to be determined using another method as determined by the RP/consultant and approved by the Air Quality Construction Permit Team.

AS System: The equations use only three variables: the designed system influent flow (pumping) rate, the maximum estimated influent pollutant concentration (based on ground water analysis) and the minimum estimated effluent pollutant concentration (based on system design efficiency). All other parameters used are either derived from these variables, or are constants. It is very important to represent the data in the units outlined in this document, and for convenience and consistency, it is strongly recommended that the worksheets in Appendix B be used.

Parameters used:

- *ER* = Pollutant emission rate (g/sec)
- Q = Influent flow (pumping) rate (L/sec)
- Cbi = Estimated maximum influent pollutant concentration(s) (g/L)
- Cbe = Minimum effluent pollutant concentration(s) (g/L)

- $3.153x10^{+7}$ = Seconds per year
- $2.205x10^{-3}$ = Conversion factor (grams to pounds)
- 2000 = Pounds per ton
- *T* = Tons of pollutant per year

ER Calculation:

$$ER = Q * (Cbi-Cbe)$$

Tonnage Calculation:

$$T = \frac{ER*3.153x10^{+7}*2.205x10^{-3}}{2000}$$

<u>SVE System</u>: The equations use only two variables: the designed system exhaust airflow rate (Q) and the maximum pollutant concentration in the exhaust air stream (Cb) (NOTE: This will require an SVE pilot test). All other parameters used are either derived from these variables or are constants. It is very important to represent the data in the units outlined in this document, and for convenience and consistency, it is strongly recommended that the worksheets in Appendix B be used.

Parameters used:

- *ER* = Pollutant emission rate (g/sec)
- Q = Exhaust air flow rate (L/sec)
- Cb = Maximum pollutant concentration(s) in the exhaust air (g/L)
- $3.153x10^{+7}$ = Seconds per year
- $2.205x10^{-3}$ = Conversion factor (grams to pounds)
- 2000 = Pounds per ton
- *T* = Tons of pollutant per year

ER Calculation:

$$ER = Q * Cb$$

Tonnage Calculation:

$$T = \frac{ER*3.153x10^{+7}*2.205x10^{-3}}{2000}$$

E. Preliminary Permit Reporting Procedures:

The emission calculations should be submitted as part of the pump test and/or the pilot test results performed for preparation of the RAP for the PR Section or in accordance with the PFP contract.

SECTION 3 EXPOSURE ASSESSMENT

A. Introduction:

The guidelines outlined in this section represent the approved activities necessary for the cancer risk assessment (process summarized in Appendix A). If used, these procedures will facilitate more effective departmental review of this information. If these procedures are not used, the procedure for proposal of alternative methods should be followed so that the NDEQ may determine if the methods proposed for use are applicable and valid.

Air stripping (AS) and soil vapor extraction (SVE) systems used in the remediation of petroleum release sites have the potential to emit hazardous substances to the atmosphere. The purpose of this section is to establish guidelines for the assessment of the cancer risk posed by these emissions and to facilitate remediation system modifications (e.g., emission control device installation, adjustment of pumping rate, modifying stack height) when necessary to protect public health.

At those sites where only petroleum is present, the carcinogenic pollutant of concern is benzene, and the cancer risk assessment is typically calculated for only benzene. Since the assessment is based on a chronic exposure to a carcinogen, the post-system implementation assessments will be conducted on the average benzene concentration for each emission point. The assessments for each emission point at a site are then summed to determine the total risk for the site. Contact the PR Section project manager if another carcinogen(s) is known to be present at the site.

B. Data Collection and Sample Analysis Procedures:

Pre-system Implementation

Data Requirements - AS System

- The designed system influent flow (pumping) rate;
- The maximum estimated influent benzene concentration, based on ground water analysis; and,
- The minimum estimated effluent benzene concentration, based on system design efficiency.

Data Requirements - SVE System

- The designed system exhaust air flow rate; and,
- The maximum benzene concentration in the exhaust air stream (NOTE: This will require an SVE pilot test).

Sample analysis methods:

- BTEX, MTBE, and n-Hexane (Water)[a]: Samples ***must*** be analyzed by methods approved by the NDEQ (Methods OA-1 or 8260 are acceptable);
- BTEX, MTBE, and n-Hexane (Air): Method 18; and,
- Air flow rate, as measured from the extraction well with a pitot tube, orifice plate or similar methods approved by the NDEQ, should follow the procedures in Sections 2A through 2E.

Post-system Implementation

The appropriate data ***must*** be collected at the following intervals:

- During the pump test and/or SVE pilot test;
- 12 hours after start of full scale system operation;
- 7 days after start of full scale system operation;
- 14 days after start of full scale system operation;
- Monthly for the next six months of full scale system operation; and,
- Sampling intervals as determined by the PR Section thereafter.

Data Requirements - AS Systems:

- Average influent benzene concentration to the AS;
- Minimum effluent benzene concentration from the AS;
- The total influent pumping rate (L/sec) for the AS; and
- If emission control devices are installed, then the following are required:
  a) Stack-samples for benzene;
  b) Volumetric-flow rate as measured directly from the stack; and,
  c) Temperature and pressure of exhaust gas as measured from the stack.

Data Requirements - SVE Systems:

- Benzene concentration of the air extracted from the geologic interval. The samples ***must*** be obtained from a location between the blower and the extraction well(s);
- Volumetric flow rate as measured directly from the extraction well(s); and,
- Temperature and pressure of exhaust gas as measured from the stack.

Sample analysis methods:

- BTEX, MTBE, and n-Hexane (Water)[b]: Samples ***must*** be analyzed by methods approved by the NDEQ (Methods OA-1 or 8260 are acceptable);
- BTEX, MTBE, and n-Hexane (Air): Method 18; and

[a] The National Pollutant Discharge Elimination System (NPDES) program requires that water samples be analyzed using methods approved in 40 CFR Part 136 (Methods 602, 624, and 1624). Contact the NPDES Permits Unit, Wastewater Section, at (402/471-4220) for additional information.

[b] The National Pollutant Discharge Elimination System (NPDES) program requires that water samples be analyzed using methods approved in 40 CFR Part 136 (Methods 602, 624, and 1624). Contact the NPDES Permits Unit, Wastewater Section, at (402/471-4220) for additional information.

- Air flow rate, as measured from the extraction well with a pitot tube, orifice plate or similar methods approved by the NDEQ, should follow procedures in Sections 2A through 2E.

Any questions regarding air analysis method approval should be directed to the Air Quality Construction Permit Team. Questions regarding water analysis method approval should be directed to the PR Section.

C. Risk Calculation - AS Systems:

The equations use only three variables: the influent flow (pumping) rate (Q), the influent benzene concentration (Cbi), and the effluent benzene concentration (Cbe). All other parameters used are either derived from these variables or are constants. For comparability purposes, it is required that the same method be used for both the influent and effluent benzene analysis. It is very important to represent the data in the units outlined in this document, and for convenience and consistency, it is strongly recommended that the worksheets in Appendix B be used. If the proposed remediation system uses more than one remediation technology (e.g., AS and SVE), which emits pollutants to the atmosphere, then the risk assessment for each system should be derived individually, and the sum of the results totaled to determine the total risk for the site.

Parameters to be used:

- *ER* = Pollutant emission rate (g/sec)
- R_{as} = Cancer risk for the air stripper
- R_{tot} = Total site cancer risk
- Q = Influent flow (pumping) rate (L/sec)
- Ca = Modeled average annual ambient benzene concentration of 343.49 $(ug/m^3)(g/sec)^{-1}$
- IUR = Inhalation unit risk factor for benzene, $8.3*10^{-6}$ $(ug/m^3)^{-1}$
- X = Proposed duration of system operation (days)
- 25550 = Continuous days of system operation in 70 years

Pre-system Implementation

- Cbi = Maximum influent benzene concentration (g/L) (can be estimated)
- Cbe = Minimum effluent benzene concentration (g/L) (can be estimated)

Post-system Implementation

- Cbi = Average influent benzene concentration (g/L)
- Cbe = Minimum effluent benzene concentration (g/L)

ER Calculation:

$$ER = Q * (Cbi-Cbe)$$

R_{as} Calculation:

$$Ras = (ER)(Ca)(IUR)\left(x/25550\right)$$

R_{tot} Calculation (If necessary):

$$R_{tot} = R_{as} + R_{sve}$$

D. Risk Calculation - SVE Systems:

The equations use only two variables: the system exhaust airflow rate (Q) and the benzene concentration in the exhaust air stream (Cb). All other parameters used are either derived from these variables or are constants. It is very important to represent the data in the units outlined in this document and for convenience and consistency it is strongly recommended that the worksheets in Appendix B be used. If the proposed remediation system uses more than one remediation technology (e.g., AS and SVE), which emits pollutants to the atmosphere, then the risk assessment for each system should be derived individually and the sum of the results calculated to determine the total risk for the site.

Parameters to be used:

- *ER* = Pollutant emission rate (g/sec)
- R_{sve} = Cancer risk for the SVE emissions
- R_{tot} = Total site cancer risk
- Q = Exhaust air flow rate (L/sec)
- Ca = Modeled average annual ambient benzene concentration of 343.49 $(ug/m^3)(g/sec)^{-1}$
- IUR = Inhalation unit risk factor for benzene, $8.3*10^{-6}$ $(ug/m^3)^{-1}$
- X = Proposed duration of system operation (days)
- 25550 = Continuous days of system operation in 70 years

Pre-system Implementation

- Cb = Maximum benzene concentration of the exhaust system (g/L)

Post-system Implementation

- Cb = Average benzene concentration of the exhaust system (g/L)

ER Calculation:

$$ER = Q * Cb$$

R_{sve} Calculation:

$$Rsve = (ER)(Ca)(IUR)\left(x/25550\right)$$

R_{tot} Calculation (If necessary):

$$R_{tot} = R_{as} + R_{sve}$$

E. Risk Assessment Procedures:

Pre-system Installation

When conducting the initial cancer risk assessment, the highest cancer risk value calculated employing the procedures outlined above should be used. If R_{tot} is determined to be greater than $1x10^{-6}$, the responsible party/consultant should be prepared to operate or modify the system in such a manner that the risk factor will not be exceeded. If the R_{tot} is less than or equal to $1x10^{-6}$ prior to system installation, then the remediation system may be installed and operated in accordance with the approved RAP or PFP contract.

Post-system Installation

Subsequent cancer risk assessments ***must*** be reevaluated after every sampling event outlined in Section 3B of this document. Since this assessment is based on chronic exposure to a carcinogen, the assessment can be conducted on the average benzene concentration (from all sampling events) for each emission point. For sites utilizing both AS and SVE systems or more than one AS or SVE system, the total cancer risk is additive. That is, the cancer risk for each air emission point ***must*** be determined individually, summed, and averaged from all sampling events. If the cumulative risk is greater than $1x10^{-6}$, the site is subject to the requirements described in Section 3F below.

As long as the R_{tot} is less than or equal to $1x10^{-6}$, the system may be operated, as approved by NDEQ. After the initial monthly sampling and analyses for six months, and if the R_{tot} is less than or equal to $1x10^{-6}$ for one year or four consecutive quarterly sampling events, the sampling frequency may be reduced when either approved or directed by the PR Section project manager or at the discretion of the PFP contractor. The petition for further sampling reduction ***must*** be in writing, be based on the average influent concentration, include the data substantiating the request, and be submitted to the PR Section.

F. Control Equipment:

If simple operational techniques are not sufficient in reducing emissions to required parameters, and additional emission control devices are necessary, then stack emission samples analyzed for benzene will be needed in order to assess the effectiveness of the treatment by that particular control device. In these instances, the cancer risk assessment ***must*** be calculated using stack-sampling results instead of the influent/effluent sampling results. However, the influent/effluent samples ***must*** still be obtained if required by another NDEQ program (e.g., NPDES).

When emission control devices have been installed as a result of the cancer risk assessment only, the RP may request to have them removed. If, after one year or four consecutive sampling events, whichever is greater, the cancer risk for the influent to the emission control device is less than $1x10^{-6}$, emission control device may be removed when either approved or directed by the PR Section project manager or at the discretion of the PFP contractor.

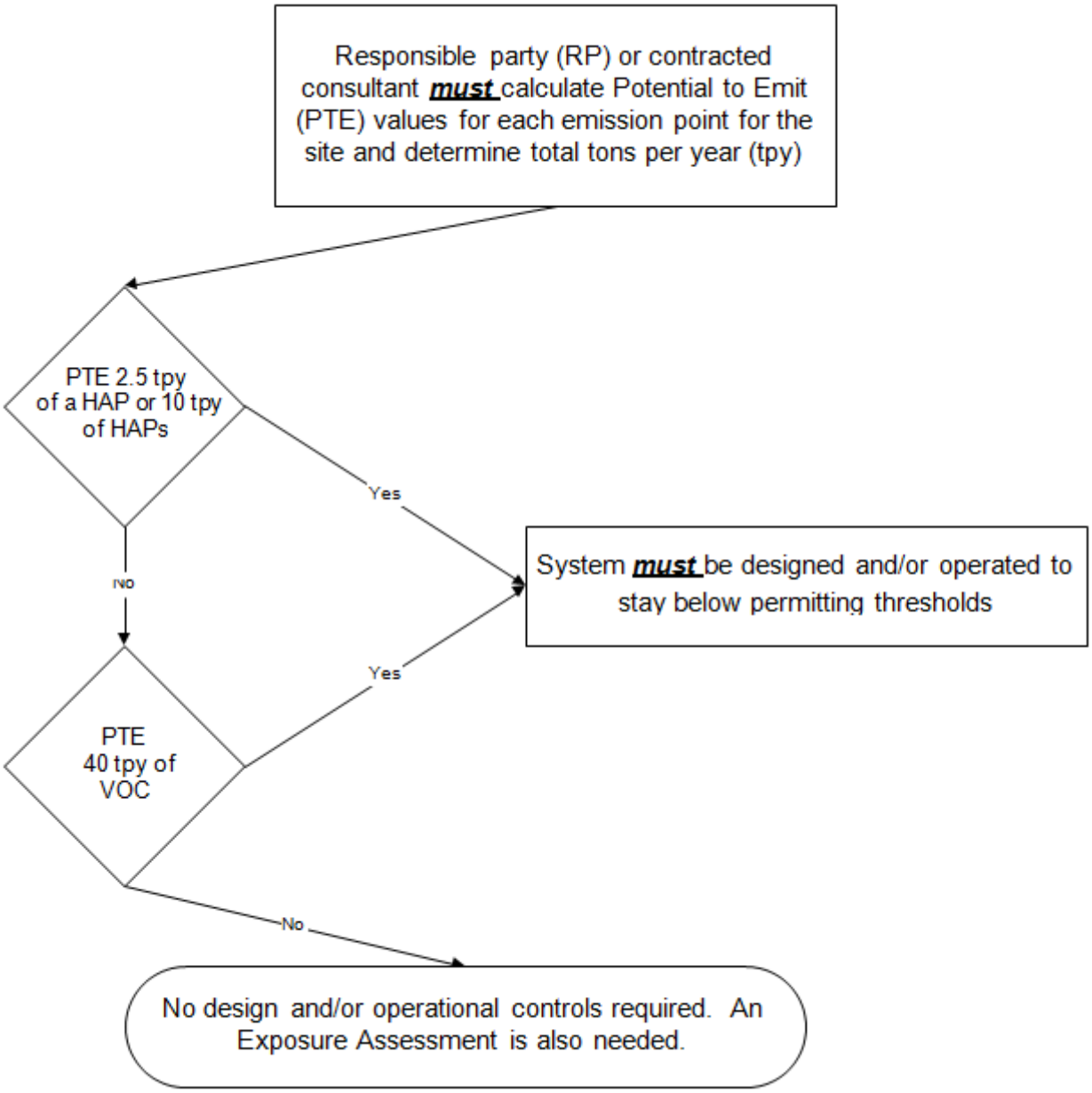
SECTION 4 REPORTING PROCEDURES

If the proposed remedial system will result in the emission of PTE contaminants that surpass the Construction and/or Operating Permit threshold levels (Section 2B) and/or the cancer risk (Section 3) is greater than $1x10^{-6}$, then it ***must*** be reported to the NDEQ project manager and the remedial system ***must*** be redesigned and best engineering practices (i.e., emissions control/treatment or system design modifications) utilized. A summary of the permitting and cancer risk data and calculations ***must*** be included with the RAP or as stated in the PFP contract.

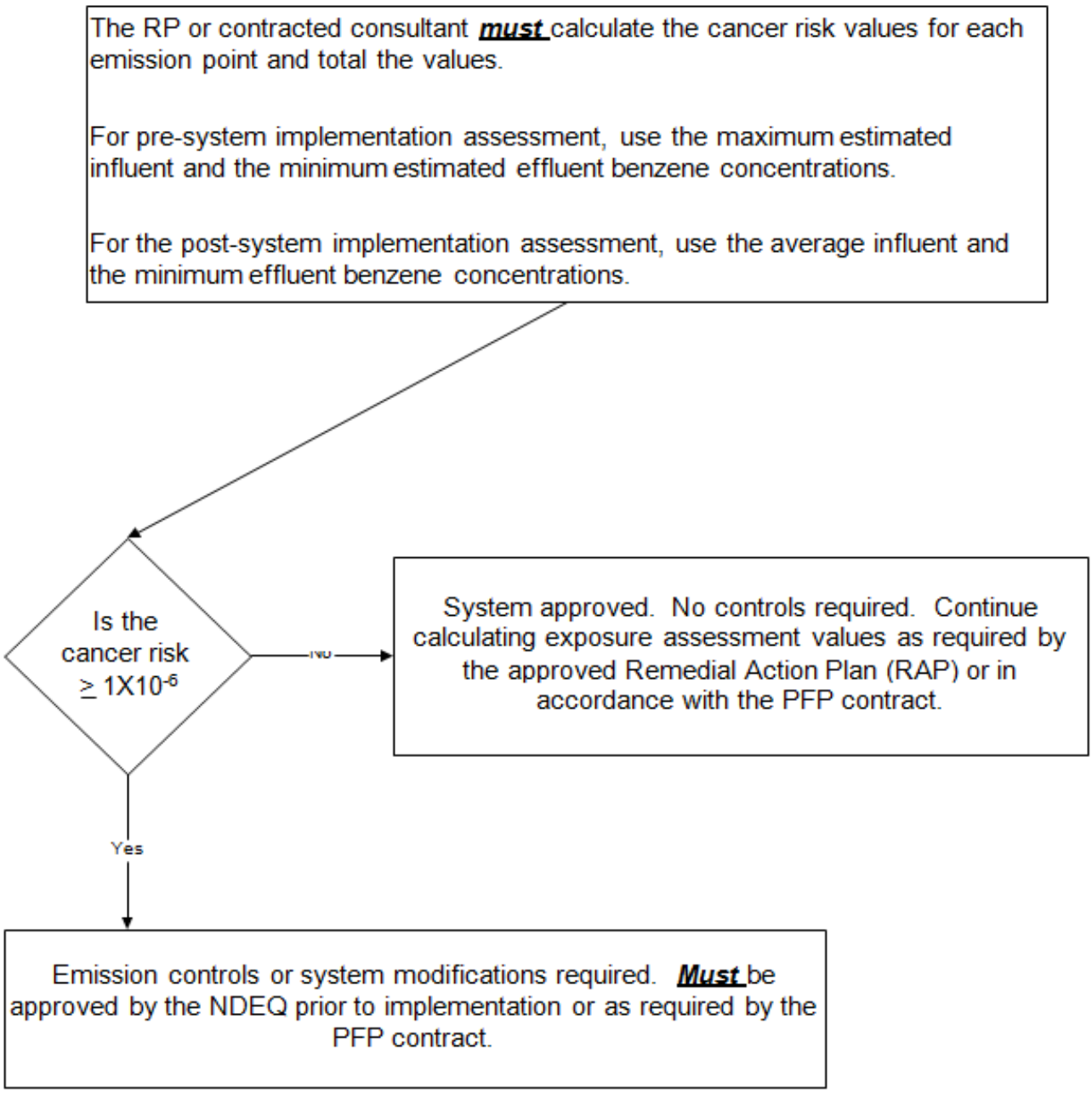
The permit requirement and cancer risk calculations from the 12 hour, 7 day, 14 day, and the 6 individual monthly sampling events shall be included as part of the first air monitoring report, due after the first six months of operation. The Department may have other ground water monitoring reports due within that period. The six-month air monitoring report must be submitted in a combined format with any other report(s) due at the same time. In addition, cancer risk

calculations are due 12 months after the start of full-scale operation. Subsequent cancer risk assessments shall be submitted with routine monitoring reports as required by the approved RAP. For those sites remediated under the PFP process, all monitoring reports required above are to be submitted in accordance with the PFP contract.

NDEQ Air Emissions Guidance for Petroleum Remediation Sites Permit Evaluation Flow Chart



NDEQ Air Emissions Guidance for Petroleum Remediation Sites Permit Evaluation Flow Chart



NDEQ Air Emissions Guidance for Petroleum Remediation Sites Permit Evaluation Flow Chart

Exposure Assessment

Both the initial and ongoing Exposure Assessments are based on the total cancer risk for the site. The RP or contracted consultant ***must*** calculate the cancer risk for each emission point at the site (i.e., each air stripper (AS) emission point and each soil vapor extraction (SVE) emission point) and then add the subtotals. The total represents the total cancer risk for the site.

AS Cancer Risk Assessment Calculations **+** SVE Cancer Risk Assessment Calculations **=** Total Cancer Risk for the site

Ongoing Exposure Assessment

Because the assessment is based on a chronic exposure to carcinogens of concern commonly found in petroleum, the assessment will be typically calculated for the average **benzene** concentration for the emission point (contact the Petroleum Remediation Section project manager if other carcinogenic VOCs are known to exist at the remediation site). The average benzene concentration is determined by adding the benzene concentration for each sampling event (SE) and then dividing by the total number of sampling events (TSE).

$$\frac{SE1 + SE2 + SE3 + \ldots}{TSE} = \text{Average Benzene Concentration}$$

PETROLEUM AIR EMISSIONS DATA SHEETS

It is very important that the pollutant concentration (Cb, Cbe or Cbi) is expressed in the proper units -- grams per Liter (g/L). If the laboratory presents the concentration in parts per million (mg/L), then it must be multiplied by 10^{-3}. If the concentration is presented in parts per billion (ug/L), then it must be multiplied by 10^{-6}. [Note: If performing a risk assessment, the pollutant of concern is typically benzene. If another carcinogenic VOC is known to exist at the remediation site, contact the Petroleum Remediation (PR) Section project manager for guidance.]

GENERAL INFORMATION

I. Air Stripping (AS) Tower Data:

A. Water Analysis Data:

1. Maximum influent water pollutant concentration (g/L): _____
2. Minimum effluent water pollutant concentration (g/L): _____
3. Analysis method: _____
4. Date and document name reported to the NDEQ:
   _____
5. Sampling date: _____
6. Sample obtained from AS tower or pump test (circle one).

B. Exhaust Air Quality Data:

1. Maximum pollutant concentrations as measured by EPA Method 18 (g/L):
   _____
2. Analysis method if other than EPA Method 18: _____
3. Sampling date: _____

C. AS Tower System Information:

1. Height of exhaust stack (in meters aboveground): _____
2. Diameter of exhaust pipe (in centimeters): _____
3. Orientation of exhaust stack (horizontal or vertical): _____
4. Maximum influent flow rate (in liters per second): _____
5. Proposed number of operating days from date of sample acquisition: _____
6. Exit velocity of released gas (in meters per second):_____
7. Temperature of released gas (in °K):_____
8. Maximum volumetric flow rate through the exhaust stack (in cubic meters per second (cms)): _

PETROLEUM AIR EMISSIONS DATA SHEETS

GENERAL INFORMATION, continued

II. Soil Vapor Extraction (SVE) System Data:

A. Exhaust Air Quality Data:

1. Maximum pollutant concentration as measured by EPA Method 18 (g/L): _____
2. Analysis method if other than EPA Method 18: _____
3. Sampling date: _____

B. SVE System Information:

1. Height of exhaust stack (in meters above ground): _____
2. Diameter of exhaust pipe (in centimeters): _____
3. Orientation of exhaust stack (horizontal or vertical): _____
4. Proposed number of operating days from the date of sample acquisition: _____
5. Exit velocity of released gas (in meters per second): _____
6. Anticipated blower flow rate (cms): _____
7. Temperature of released gas (in °K): _____
8. Maximum measured volumetric flow rate through the exhaust stack (in cubic meters per second (cms)): _

AIR PERMIT ASSESSMENTS

It is very important that the pollutant concentrations (Cb) are expressed in the proper units.

I. AS Tower Emission Permit Assessment:

A. Parameters to be used:

- *ER* = Pollutant emission rate (g/sec),
- Q = Influent flow (pumping) rate (L/sec),
- Cbi = Average influent pollutant concentration (g/L),
- Cbe = Minimum effluent pollutant concentration (g/L),
- $3.153 \times 10^{+7}$ = Seconds per year,
- 2.205×10^{-3} = Conversion factor (grams to pounds),
- 2000 = Pounds per ton,
- *T* = Tons of pollutant per year.

PETROLEUM AIR EMISSIONS DATA SHEETS

AIR PERMIT ASSESSMENTS, continued

B. ER Calculation:

ER = Q * (Cbi-Cbe)

$$ER = \{_____\ L/\sec\}\{_____\ Cbi(g/L) - _____\ Cbe(g/L)\}$$

$$ER = _____\ g/\sec$$

C. Tonnage Calculation:

$$T = \frac{ER * 3.153x10^{+7} * 2.205x10^{-3}}{2000}$$

$$T = \frac{(_____\ g/\sec) * 3.153x10^{+7} * 2.205x10^{-3}}{2000}$$

II. SVE System Emission Permit Assessment:

A. Parameters to be used:

- ER = Pollutant emission rate (g/sec),
- Q = Exhaust air flow rate (L/sec),
- Cb = Average pollutant concentration in the exhaust air (g/L),
- $3.153x10^{+7}$ = Seconds per year,
- $2.205x10^{-3}$ = Conversion factor (grams to pounds),
- 2000 = Pounds per ton,
- T = Tons of pollutant per year.

B. ER Calculation:

ER = Q * Cb

$$ER = \{_____\ L/\sec\}\{_____\ Cb(g/L)\}$$

$$ER = _____\ g/\sec$$

C. Tonnage Calculation:

$$T = \frac{ER * 3.153x10^{+7} * 2.205x10^{-3}}{2000}$$

$$T = \frac{(_____\ g/\sec) * 3.153x10^{+7} * 2.205x10^{-3}}{2000}$$

PETROLEUM AIR EMISSIONS DATA SHEETS

CANCER RISK ASSESSMENTS

<u>Note:</u> It is very important that the benzene concentration (Cb) is expressed in the proper units. (Note: If another carcinogenic VOC is known to exist at the remediation site, contact the PR Section project manager for guidance.)

I. AS Tower Emission Cancer Risk Assessment:

A. Parameters To Be Used:

- *ER* = Pollutant (typically benzene) emission rate (g/sec),
- R_{AS} = Cancer risk for the air stripper,
- Q = Influent flow (pumping) rate (L/sec),
- Cbi = Average influent benzene concentration (g/L),
- Cbe = Minimum effluent benzene concentration (g/L),
- Ca = Modeled average annual ambient benzene concentration of 343.49 $(ug/m^3)(g/\sec)^{-1}$
- IUR = Inhalation unit risk factor for benzene, $8.3*10^{-6}$ $(ug/m^3)^{-1}$
- X = Proposed duration of system operation (days)
- 25550= Continuous days of system operation in 70 years

B. ER Calculation:

ER = Q * (Cbi-Cbe)

$$ER = \{_____\ L/\sec\}\{_____\ Cbi(g/L) - _____\ Cbe(g/L)\}$$

$$ER = _____\ g/\sec$$

C. R_{as} Calculation:

$$Ras = (ER)(Ca)(IUR)\left(\frac{x}{25550}\right)$$

$$Ras = \{____(g/\sec)\}\{343.49(ug/m^3)(g/\sec)^{-1}\}\{8.3*10^{-6}(ug/m^3)^{-1}\}\left\{\frac{____(days)}{25550}\right\}$$

$$Ras = _____$$

PETROLEUM AIR EMISSIONS DATA SHEETS

III. SVE System Emission Cancer Risk Assessment:

A. Parameters to be used:

- *ER* = Pollutant emission (typically benzene) rate (g/sec),
- R_{SVE} = Cancer risk for the SVE emissions,
- Q = Exhaust air flow rate (L/sec),
- Cb = Average benzene concentration of the exhaust air system (g/L),
- Ca = Modeled average annual ambient benzene concentration of 343.49 $(ug/m^3)(g/\sec)^{-1}$
- IUR = Inhalation unit risk factor for benzene, $8.3*10^{-6}$ $(ug/m^3)^{-1}$
- X = Proposed duration of system operation (days)
- 25550= Continuous days of system operation in 70 years

B. ER Calculation:

ER = Q * Cb

$$ER = \{_____\ L/\sec\}\{_____\ Cb(g/L)\}$$

$$ER = _____\ g/\sec$$

C. R_{sve} Calculation:

$$Rsve = (ER)(Ca)(IUR)\left(\frac{x(days)}{25550}\right)$$

$$Rsve = \{____(g/\sec)\}\{343.49(ug/m^3)(g/\sec)^{-1}\}\{8.3*10^{-6}(ug/m^3)^{-1}\}\left\{\frac{____(days)}{25550}\right\}$$

$$Rsve = _____$$

V. Total Site Cancer Risk Assessment:

Calculate the total site cancer risk (R_{tot}):

$$Rtot = Ras + Rsve$$

$$Rtot = _____ + _____$$

$$Rtot = _____$$

PETROLEUM AIR EMISSIONS DATA SHEETS

PETROLEUM AIR STRIPPING TOWER

AIR EMISSIONS DATA SHEET

STACK GAS DATA	**SAMPLING DATES**								**Average**
Pollutant (mg/L) _____									
Pollutant Analysis Method									
Gas Exit Velocity (m/sec)									
Gas Temperature (°K)									
Gas Volumetric Flow Rate (cms)									

PETROLEUM SOIL VAPOR EXTRACTION SYSTEM

AIR EMISSIONS DATA SHEET

STACK GAS DATA	**SAMPLING DATES**								**Average**
Pollutant (mg/L) _____									
Pollutant Analysis Method									
Gas Exit Velocity (m/sec)									
Gas Temperature (°K)									
Gas Volumetric Flow Rate (cms)									
Vacuum Applied at Extraction Well (inches of water)									

PETROLEUM AIR EMISSIONS DATA SHEETS

PETROLEUM AIR STRIPPING TOWER

WATER QUALITY DATA SHEET

INFLUENT WATER DATA	**SAMPLING DATES**								**Average**
Pollutant (mg/L) _____									
Pollutant Analysis Method									
Influent Flow Rate (L/sec)									
Sample Type (pump test, etc.)									
EFFLUENT WATER DATA	**SAMPLING DATES**								
Pollutant (mg/L) _____									
Pollutant Analysis Method									
Influent Flow Rate (L/sec)									
Sample Type (pump test, etc.)									

HAZARDOUS AIR POLLUTANTS

Chemical Name	CAS Number
Acetaldehyde	75-07-0
Acetamide	60-35-5
Acetonitrile	75-05-8
Acetophenone	98-86-2
2-Acetylaminofluorene	53-96-3
Acrolein	107-02-8
Acrylamide	79-06-1
Acrylic acid	79-10-7
Acrylonitrile	107-13-1
Allyl chloride	107-05-1
4-Aminobiphenyl	92-67-1
Aniline	62-53-3
o-Anisidine	90-04-0
Asbestos	1332-21-4
Benzene	71-43-2
Benzidine	92-87-5
Benzotrichloride	98-07-7
Benzyl chloride	100-44-7
Biphenyl	92-52-4
Bis(2-ethylhexyl) phthalate	117-81-7
Bis(chloromethyl)ether	542-88-1
Bromoform	75-25-2
1,3-Butadiene	106-99-0
Calcium cyanamide	156-62-7
Captan	133-06-2
Carbaryl	63-25-2
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Carbonyl sulfide	463-58-1
Catechol	120-80-9
Chloramben	133-90-4
Chlordane	57-74-9
Chlorine	7782-50-5
Chloroacetic acid	79-11-8
2-Chloroacetophenone	532-27-4
Chlorobenzene	108-90-7
Chlorobenzilate	510-15-6
Chloroform	67-66-3
Chloromethyl methyl ether	107-30-2
Chloroprene	126-99-8
Cresols (mixed isomers)	1319-77-3
m-Cresol	108-39-4
o-Cresol	95-48-7
p-Cresol	106-44-5
Cumene	98-82-8
2,4-D	94-75-7
DDE	3547-04-4
Diazomethane	334-88-3
Dibenzofuran	132-64-9

Chemical Name	CAS Number
1,2-Dibromo-3-chloropropane	96-12-8
Dibutyl phthalate	84-74-2
1,4-Dichlorobenzene	106-46-7
3,3'-Dichlorobenzidine	91-94-1
Dichloroethyl ether (Bis(2-chloroethyl)ether)	111-44-4
1,3-Dichloropropene (1,3-Dichloropropylene)	542-75-6
Dichlorvos	62-73-7
Diethanolamine	111-42-2
N,N-Diethyl aniline (N,N-Dimethylaniline)	121-69-7
Diethyl sulfate	64-67-5
3,3-Dimethoxybenzidine	119-90-4
4-Dimethylaminoazobenzene	60-11-7
3,3-Dimethylbenzidine	119-93-7
Dimethylcarbamyl chloride	79-44-7
Dimethyl formamide	68-12-2
1,1-Dimethyl hydrazine	57-14-7
Dimethyl phthalate	131-11-3
Dimethyl sulfate	77-78-1
4,6-Dinitro-o-cresol	534-52-1
2,4-Dinitrophenol	51-28-5
2,4-Dinitrotoluene	121-14-2
1,4-Dioxane (1,4-Diethyleneoxide)	123-91-1
1,2-Diphenylhydrazine	122-66-7
Epichlorohydrin (1-Chloro-2,3-epoxypropane)	106-89-8
1,2-Epoxybutane (1,2-Butylene oxide)	106-88-7
Ethyl acrylate	140-88-5
Ethylbenzene	100-41-4
Ethyl carbamate (Urethane)	51-79-6
Ethyl chloride (Chloroethane)	75-00-3
Ethylene dibromide (1,2-Dibromoethane)	106-93-4
Ethylene dichloride (1,2-Dichloroethane)	107-06-2
Ethylene glycol	107-21-1
Ethyleneimine (Aziridine)	151-56-4
Ethylene oxide	75-21-8
Ethylene thiourea	96-45-7
Ethylidene dichloride (1,1-Dichloroethane)	75-34-3
Formaldehyde	50-00-0
Heptachlor	76-44-8
Hexachlorobenzene	118-74-1
Hexachloro-1,3-butadiene	87-68-3

HAZARDOUS AIR POLLUTANTS

Chemical Name	CAS Number
Hexachlorocyclopentadiene	77-47-4
Hexachloroethane	67-72-1
Hexamethylene-1,6-diisocyanate	822-06-0
Hexamethylphosphoramide	680-31-9
Hexane	110-54-3
Hydrazine	302-01-2
Hydrochloric acid	7647-01-0
Hydrogen fluoride	7664-39-3
Hydroquinone	123-31-9
Isophorone	78-59-1
Lindane	58-89-9
Maleic anhydride	108-31-6
Methanol	67-56-1
Methoxychlor	72-43-5
Methyl bromide (Bromomethane)	74-83-9
Methyl chloride (Chloromethane)	74-87-3
Methyl chloroform (1,1,1-Trichloroethane)	71-55-6
Methyl ethyl ketone	78-93-3
Methyl hydrazine	60-34-4
Methyl iodide (Iodomethane)	74-88-4
Methyl isobutyl ketone (Hexone)	108-10-1
Methyl isocyanate	624-83-9
Methyl methacrylate	80-62-6
Methyl tert-butyl ether	1634-04-4
4,4-Methylenebis(2-chloro)aniline	101-14-4
Methylene chloride (Dichloromethane)	75-09-2
Methylene diphenyl diisocyanate (MDI)	101-68-8
4,4'-Methylenedianiline	101-77-9
Naphthalene	91-20-3
Nitrobenzene	98-95-3
4-Nitrobiphenyl	92-93-3
4-Nitrophenol	100-02-7
2-Nitropropane	79-46-9
N-Nitrosodimethylamine	62-75-9
N-Nitrosomorpholine	59-89-2
N-Nitroso-N-methylurea	684-93-5
Parathion	56-38-2
Pentachloronitrobenzene (Quintozene)	82-68-8
Pentachlorophenol	87-86-5
Phenol	108-95-2
p-Phenylenediamine	106-50-3

Chemical Name	CAS Number
Phosgene	75-44-5
Phosphine	7803-51-2
Phosphorous	7723-14-0
Phthalic anhydride	85-44-9
PCBs	1336-36-3
1,3- Propane sultone	1120-71-4
beta-Propiolactone	57-57-8
Propionaldehyde	123-38-6
Propoxur (Baygon)	114-26-1
Propylene dichloride (1,2 Dichloropropane)	78-87-5
Propylene oxide	75-56-9
Propylenimine (2-Methyl aziridine)	75-55-8
Quinoline	91-22-5
Quinone	106-51-4
Styrene	100-42-5
Styrene oxide	96-09-3
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethylene (Perchloroethylene)	127-18-4
Titanium tetrachloride	7550-45-0
Toluene	108-88-3
2,4-Toluene diamine	95-80-7
Toluene-2,4-diisocyanate	584-84-9
o-Toluidene	95-53-4
Toxaphene	8001-35-2
1,2,4-Trichlorobenzene	120-82-1
1,1,2-Trichloroethane	79-00-5
Trichloroethylene	79-01-6
2,4,5-Trichlorophenol	95-95-4
2,4,6-Trichlorophenol	88-06-2
Triethylamine	121-44-8
Trifluralin	1582-09-8
2,2,4-Trimethylpentane	540-84-1
Vinyl acetate	108-05-4
Vinyl bromide	593-60-2
Vinyl chloride	75-01-4
Vinylidene chloride (1,1-Dichloroethylene)	75-35-4
Xylene (mixed isomers)	1330-20-7
m-Xylene	108-38-3
o-Xylene	95-47-6
p-Xylene	106-42-3

HAZARDOUS AIR POLLUTANTS

Chemical Name	CAS Number
Antimony compounds:	
Antimony	7440-36-0
Arsenic compounds (inorganic including arsine)	
Arsenic	7440-38-2
Arsine	
Beryllium Compounds	
Beryllium	7440-41-7
Cadmium Compounds	
Cadmium	7440-43-9
Chromium compounds	
Chromium	7440-47-3
Cobalt compounds	
Cobalt	7440-48-4
Coke oven emissions	
Cyanide compounds (XCN where X=H or any other group where a formal dissociation may occur)	
Hydrogen cyanide	74-90-8
Glycol ethers - include mono- and di- ethers of ethylene glycol, diethylene glycol, and triethylene glycol R-(OCH2CH2)n-OR' where n = 1, 2, or 3 R = alkyl or aryl groups R' = R, H, or groups which, when removed, yield glycol ethers with the structure: R-(OCH2CH)n-OH Polymers are excluded from the glycol category	

Chemical Name	CAS Number
Lead compounds	
Lead	7439-92-1
Manganese compounds	
Manganese	7439-96-5
Mercury compounds	
Mercury	7439-97-6
Mineral fibers {includes glass microfibers, glass wool fibers, rock wool fibers and slag wool fibers, each characterized as "respirable" (fiber diameter < 3.5 micrometers) and possessing an aspect ratio (fiber length divided by fiber diameter) > 3}	
Nickel compounds	
Nickel	7440-02-0
POM (includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100C)	
Radionuclides (a type of atom which spontaneously undergoes radioactive decay)	
Selenium compounds	
Selenium	7782-49-2