Public Health Assessment for

OAK RIDGE RESERVATION (USDOE)
TSCA INCINERATOR
OAK RIDGE, ROANE COUNTY, TENNESSEE
EPA FACILITY ID: TN1890090003
MARCH 1, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

Comment Period Ends:

MAY 6, 2005

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment-Public Comment Release was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate. This document represents the agency's best efforts, based on currently available information, to fulfill the statutory criteria set out in CERCLA section 104 (i)(6) within a limited time frame. To the extent possible, it presents an assessment of potential risks to human health. Actions authorized by CERCLA section 104 (i)(11), or otherwise authorized by CERCLA, may be undertaken to prevent or mitigate human exposure or risks to human health. In addition, ATSDR will utilize this document to determine if follow-up health actions are appropriate at this time.

This document has previously been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i) (6) (H) for their information and review. Where necessary, it has been revised in response to comments or additional relevant information provided by them to ATSDR. This revised document has now been released for a 30-day public comment period. Subsequent to the public comment period, ATSDR will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This will conclude the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

Please address comments regarding this report to:

Agency for Toxic Substances and Disease Registry
Attn: Division of Health Assessment and Consultation (E-60)
1600 Clifton Road, N.E., Atlanta, Georgia 30333

You May Contact ATSDR TOLL FREE at
1-888-42ATSDR or
Visit our Home Page at: http://www.atsdr.cdc.gov

PUBLIC HEALTH ASSESSMENT

OAK RIDGE RESERVATION (USDOE)

TSCA INCINERATOR

OAK RIDGE, ROANE COUNTY, TENNESSEE

EPA FACILITY ID: TN1890090003

Prepared by:

U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
Atlanta, Georgia

Foreword

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and cleanup of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements. The public health assessment program allows the scientists flexibility in the format or structure of their response to the public health issues at hazardous waste sites. For example, a public health assessment could be one document or it could be a compilation of several health consultations — the structure may vary from site to site. Whatever the form of the public health assessment, the process is not considered complete until the public health issues at the site are addressed.

Exposure

As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects

If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances than adults. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high-risk groups within the community (such as the elderly, chronically ill, and people engaging in high-risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic, and epidemiologic studies and the data collected in disease registries, to determine the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When it touches on cases in which this is so, this report suggests what further public health actions are needed.

Conclusions

This report presents conclusions about the public health threat, if any, posed by a site. Any health threats that have been determined for high-risk groups (such as children, the elderly, chronically ill people, and people engaging in high-risk practices) are summarized in the Conclusions section of the report. Ways to stop or reduce exposure are recommended in the Public Health Action Plan section.

ATSDR is primarily an advisory agency, so its reports usually identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Community

ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments

If, after reading this report, you have questions or comments, we encourage you to send them to us. Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch
Agency for Toxic Substances and Disease Registry
1600 Clifton Road (E-60)
Atlanta, GA 30333

Table of Contents

Tables and Figures

List of Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CNF	Central Neutralization Facility
CREG	Cancer Risk Evaluation Guide
DCG	Derived Concentration Guide
DOE	U.S. Department of Energy
DRE	destruction and removal efficiency
EMEG	Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
ERAMS	Environmental Radiation Ambient Monitoring System
ETTP	East Tennessee Technology Park
ISCST	Industrial Source Complex, Short Term
LLNL	Lawrence Livermore National Laboratory
MACT	maximum achievable control technology
mixed LLW	mixed low-level radioactive and hazardous waste
MRL	Minimal Risk Level
NAAQS	National Ambient Air Quality Standard
NEI	National Emissions Inventory
NESHAPs	National Emissions Standards for Hazardous Air Pollutants
NIOSH	National Institute for Occupational Safety and Health
NPL	National Priorities List
NTP	National Toxicology Program
ORNL	Oak Ridge National Laboratory

ORR	Oak Ridge Reservation
ORRHES	Oak Ridge Reservation Health Effects Subcommittee
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PHA	public health assessment
PHAWG	Public Health Assessment Work Group
PM	particulate matter
PM10	particulate matter with aerodynamic diameters less than 10 microns
PM2.5	particulate matter with aerodynamic diameters less than 2.5 microns
POHC	principal organic hazardous constituent
ppm	parts per million
RBC-N	risk-based concentration for non-cancer effects
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
TDEC	Tennessee Department of Environment and Conservation
TDOH	Tennessee Department of Health
TEQ	toxic equivalent
TLD	thermoluminescent dosimeter
TRI	Toxics Release Inventory
TRV	thermal relief vent
TSCA	Toxic Substances Control Act
TSP	total suspended particulates
TVA	Tennessee Valley Authority
UCLA	University of California at Los Angeles
VOC	volatile organic compound

I. Summary

This public health assessment (PHA) evaluates environmental exposures to contaminants released from the "TSCA Incinerator" at the U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR) in Roane County, Tennessee. The incinerator's name comes from the Toxic Substances Control Act, or TSCA, one of the environmental regulations governing the incinerator's operations. DOE contractors operate the TSCA Incinerator at a facility currently known as East Tennessee Technology Park (ETTP), formerly known as the K-25 site and as the Oak Ridge Gaseous Diffusion Plant. The TSCA Incinerator destroys organic chemicals in waste material and reduces the volume of waste materials that contain low-level radioactive contamination. The TSCA Incinerator began routine operations in 1991, and continues to operate today.

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this PHA to evaluate environmental health issues related to the TSCA Incinerator. The scientific approaches used in this PHA are consistent with relevant policies and guidance documents that ATSDR and other agencies have developed specifically for assessing human health risks posed by incineration facilities.

> **What are the objectives of this PHA?** (1) To determine whether local residents, other than workers, have been harmed by contaminants released by the TSCA Incinerator; (2) to respond to specific community concerns about the TSCA Incinerator; and (3) to make recommendations to help ensure that residents will not be exposed to harmful levels of site-related contaminants in the future.

This PHA's conclusions are based largely on environmental sampling data, stack tests, and other records generated by multiple parties. Over the last 2 years, ATSDR obtained documents and insights from

- the U.S. Environmental Protection Agency,
- the Tennessee Department of Environment and Conservation,
- the Tennessee Valley Authority,
- the DOE and its contractors,
- a group of independent experts chartered by the Governor of Tennessee,
- members of the Public Health Assessment Working Group (now known as the Exposure Evaluation Work Group),
- the ORR Local Oversight Committee, and
- local community members.

ATSDR considered all information provided by these parties when preparing this PHA.

The TSCA Incinerator has been studied extensively and continuously since it began routine operations in 1991. Multiple parties have quantified what the TSCA Incinerator releases into the air, modeled how contaminants move through the air, and measured what levels of air contamination are found beyond the ETTP facility property line. To date, ATSDR has reviewed tens of thousands of environmental measurements taken over the entire time that the TSCA Incinerator has operated. This PHA's conclusions, therefore, are based on an extremely large volume of data, especially when compared with data available for other incineration facilities that ATSDR has evaluated over the years. The remainder of this section presents ATSDR's key findings on the TSCA Incinerator, starting with the main conclusion, followed by summary statements on other issues.

Main Conclusion

The TSCA Incinerator releases trace levels of contaminants into the environment, but in amounts far below levels associated with health effects. Continued operation of the TSCA Incinerator is not expected to cause harmful exposures because numerous safeguards, pollution controls, and strict permitting requirements are in place to prevent unsafe operating conditions from occurring.

The following paragraphs review ATSDR's key findings on several individual topics. As Figure 1 illustrates, these individual findings paint a consistent picture of the limited air quality impacts from the TSCA Incinerator, and they form the foundation for the main conclusion stated above.

- **Design and operation of the TSCA Incinerator.** The TSCA Incinerator is designed to meet the strict requirements of multiple environmental regulations intended to protect human health and the environment. The TSCA regulations, for instance, require the incinerator to destroy at least 99.9999% of polychlorinated biphenyls (PCBs) in wastes. To reduce environmental impacts, a series of air pollution control devices minimize releases from the incinerator into the atmosphere. Moreover, sophisticated controls automatically shut down the entire incineration process if operating conditions are not maintained within limits specified in health-protective environmental permits. Using these and other observations, ATSDR concludes that the TSCA Incinerator is designed and is operated in a manner consistent with current best practices for thermal treatment facilities.

- **Amounts and types of wastes treated by the TSCA Incinerator.** The TSCA Incinerator treats liquid and solid wastes that contain various hazardous chemicals, including radioactive contaminants. All wastes must be thoroughly characterized before they arrive at the TSCA Incinerator, and their contamination levels must meet strict criteria before they can be treated. Health-protective environmental permits dictate the maximum amount of waste that the incinerator can process each year. In recent years, the amount of waste treated at the TSCA Incinerator has been only 5% of the permitted limits. In short, systems are in place to help ensure that the TSCA Incinerator does not process wastes that cannot be treated safely.

- **Air emissions from the TSCA Incinerator.** Stack tests and trial burns have measured emission rates under various operating scenarios for the eight groups of contaminants considered in this PHA:
    - particulate matter,
    - volatile organic compounds,
    - PCBs,
    - metals,
    - acidic gases,
    - dioxins and furans,
    - polycyclic aromatic hydrocarbons, and
    - radionuclides.

  With few exceptions, measured emission rates have been below health-protective limits established in the incinerator's environmental permits. In the isolated instances where higher emission rates were observed, ambient air monitoring data collected at the time show that air contamination at off-site locations was not affected.

- **Dispersion modeling studies of the TSCA Incinerator's air emissions.** Both the independent panel previously chartered by the Governor of Tennessee and DOE have conducted extensive air modeling studies to understand how emissions from the TSCA Incinerator move through the air to off-site locations. ATSDR has also conducted a modeling evaluation to account for limitations in the previous studies. While air quality models have inherent uncertainties and can only estimate a source's potential air quality impacts, all three studies strongly suggest that the TSCA Incinerator's air quality impacts at off-site locations are minimal — a finding that has been supported by trends in the extensive air quality measurements at this site.

- **Relevant air quality measurements.** Since the TSCA Incinerator began treating wastes in 1991, multiple parties have measured the site's potential air quality effects. These studies have appropriately focused on contaminants that incinerators cannot destroy, such as metals, particulates, and radionuclides. Several thousand ambient air sampling results are available for numerous locations that surround the TSCA Incinerator, including locations where air models predict the greatest impacts. These measurements strongly suggest that air emissions from the incinerator do not cause exposure levels of public health concern at off-site locations. Section IX of this PHA presents ATSDR's recommendations for enhancing the ongoing ambient air monitoring activities.

Although the previous statements clearly support ATSDR's main conclusion for this site, it has become apparent to ATSDR that some community members have long-standing health concerns about the incinerator's ongoing operations, despite evidence suggesting that the site does not cause unhealthful exposures. To bridge this information gap, ATSDR recommends that TDEC annually issue fact sheets to brief residents on the incinerator's ongoing operations. These fact sheets should address inspection outcomes, regulatory compliance, agency oversight, and quantitative comparison of environmental sampling results collected by various parties.

When preparing this PHA, ATSDR identified regional air quality issues of potential health concern; namely, air quality across the Knoxville metropolitan area is occasionally poor when airborne levels of ozone and fine particles reach unhealthful levels. These air quality issues are regional in nature and result from industrial and motor vehicle emissions over a broad geographic area — emissions from the TSCA Incinerator appear to contribute little to these problems. When exposed to elevated levels of these pollutants, some people — particularly children, the elderly, and those with respiratory conditions — could experience lung irritation, difficulty breathing, and other health effects. On days with poor air quality, TDEC issues warnings that explain how people can reduce their exposure and how they can avoid adverse health effects. It is especially important for residents to heed these warnings and for adults to convey these warnings to their children, particularly asthmatic children.

The remainder of this PHA describes how ATSDR reached the conclusions and summary statements listed above. Those interested in only a brief summary of the main conclusions and recommendations should proceed to Sections VIII through X of this PHA. Those interested in a detailed account of ATSDR's scientific analyses are encouraged to read the entire report. Appendixes E and F of this PHA present a glossary and definitions of units of measurement used throughout this report.

II. Background

Since 1942, the U.S. government and contractors have conducted various research and development activities at the Oak Ridge Reservation (ORR), located in Anderson and Roane Counties in Tennessee. These activities were primarily conducted at four separate facilities previously known as the Y-12 plant, the K-25 site, the S-50 site, and the X-10 site. For much of ORR's history, the research and development activities focused on designing and producing materials and components for nuclear weapons. In recent years, however, the ORR facilities' missions have changed considerably. While some ORR facilities continue to conduct nuclear research and production projects vital to national security, other ORR facilities devote considerable resources to environmental research and restoration.

The U.S. Department of Energy's (DOE's) environmental restoration activities address contamination that remains from past research, development, and production operations. A challenge faced by DOE has been how to handle "mixed wastes," or wastes that contain both chemical and radioactive contamination.

What is "mixed low-level radioactive and hazardous waste?" Waste management regulations define what materials should be considered "hazardous waste" and what materials should be considered "radioactive waste." Some wastes, however, meet the criteria set forth in both definitions. Such materials are considered "mixed low-level radioactive and hazardous waste," which is commonly referred to as mixed LLW. Depending on the source of the waste, mixed LLW can be liquid or solid. The TSCA Incinerator treats mixed LLW.

One way DOE and its contractors have addressed the challenge of mixed LLW is to design and operate an incinerator that treats and reduces the volume of waste materials. The incinerator is located at East Tennessee Technology Park (ETTP), formerly the K-25 site (see Figure 2). The incinerator is commonly known as the "TSCA Incinerator" because this operation is authorized under the Toxic Substances Control Act (TSCA) to treat wastes containing polychlorinated biphenyls (PCBs). The incinerator is also permitted under the Resource Conservation and Recovery Act (RCRA) to treat hazardous wastes. Construction of the incinerator was completed in 1989, and the incinerator began routinely treating wastes from ORR and other DOE facilities in 1991. The TSCA Incinerator continues to operate today.

This public health assessment (PHA) evaluates the public health implications of environmental releases from the TSCA Incinerator, including air emissions, solid wastes, and discharges to surface water. This PHA focuses almost entirely on *environmental* health concerns; that is, whether local residents living in communities near ETTP have contacted contamination at levels that might cause health problems. ATSDR is aware that some residents also have concerns about past and ongoing *occupational* exposures to contaminants at ORR. However, ATSDR's mandate does not include evaluating most occupational exposure scenarios. Those who are interested in learning more about occupational health issues for this site should refer to resources listed in Section V of this PHA.

This PHA presents the most extensive environmental health review to date of the TSCA Incinerator. ATSDR gathered and critically reviewed data and reports published by many parties, including environmental and health agencies, a local citizens' oversight committee, DOE and its contractors, and a group of independent experts chartered by the Governor of Tennessee. The PHA examines emissions monitoring data, environmental sampling data, and other observations that were collected over the entire history of the TSCA Incinerator's operations.

ATSDR's approach to evaluating the TSCA Incinerator started with collecting background information on topics such as operational history, community health concerns, environmental setting, and demographics. This section summarizes background information by presenting facts and observations about the TSCA Incinerator without any analyses or interpretations. Later sections in this report (Sections III through VII) describe how the background information fits into the overall environmental health analysis.

II.A. Site and Process Description

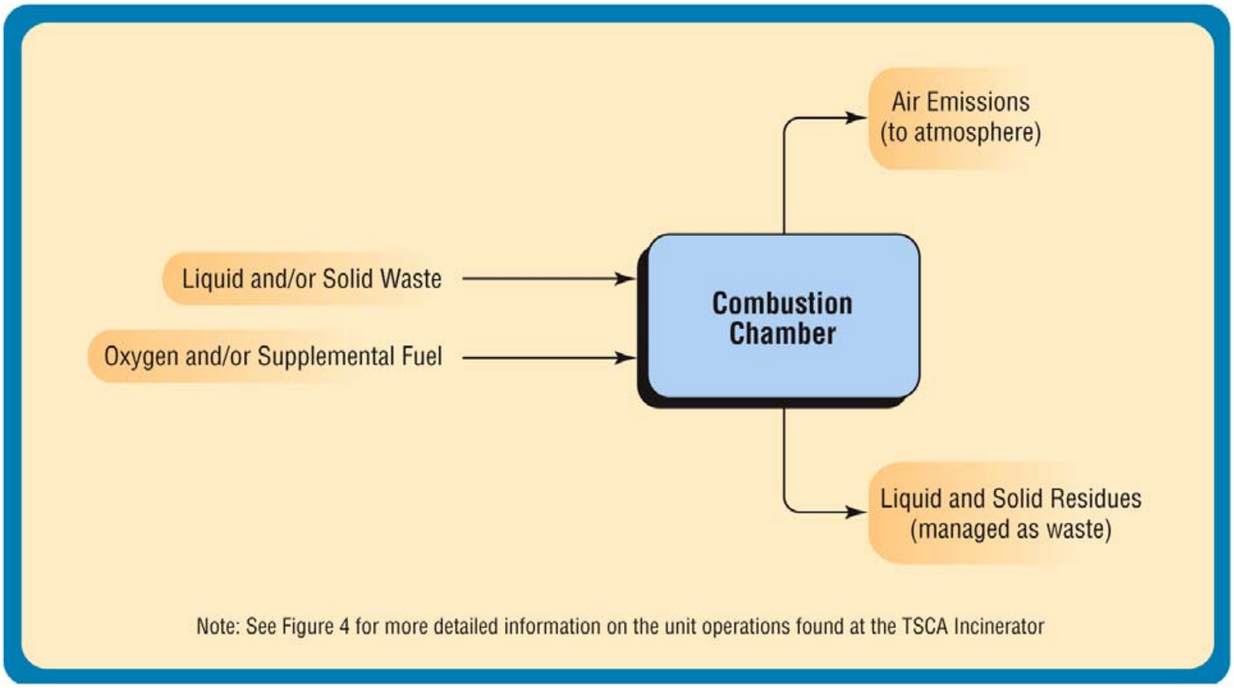
As Figure 2 shows, the TSCA Incinerator is located in the northeast corner of ETTP, which was formerly known as both the K-25 site and the Oak Ridge Gaseous Diffusion Plant. ETTP spans approximately 700 acres to which the public has no access, unless accompanied by an escort from the facility (see Section II.D). DOE constructed the TSCA Incinerator to help manage a growing volume of mixed LLW generated from various processes at ORR and at other DOE facilities. The purpose of the incinerator is to reduce the amount of waste that requires management, both by destroying hazardous organic chemicals in wastes and by reducing the volume of wastes containing radionuclides. The remainder of this section provides background information on incineration technology (see Section II.A.1) and describes the unit operations in the TSCA Incinerator (see Section II.A.2).

II.A.1 General Information on Incineration

Incinerators burn waste, thereby destroying some waste materials and reducing the volume of others. Although many different incineration technologies exist, nearly all incineration facilities share some common input and output streams, as Figure 3 depicts. The primary inputs at most incineration facilities are the wastes to be treated, along with oxygen and additional fuel to support combustion. Incineration occurs within combustion chambers, which destroys most organic material in waste, but in the process generates two general types of output streams:

- **Air emissions.** All incinerators have air emissions. Stack air emissions are gaseous, vapor, and particle-bound by-products of combustion. More information on these emissions is presented later in the section. Facilities also have fugitive air emissions, which are releases to the air from process points other than stacks (e.g., equipment leaks, wind-blown dust). The design of an incinerator largely determines the amount of fugitive air emissions that might occur. Refer to Section III.B for more information on the specific contaminants released from the TSCA Incinerator, both in fugitive and in stack emissions.

Figure 3. Generic Process Streams at Most Incineration Facilities



- **Residuals.** Incineration facilities also generate solid and liquid residuals. These typically include wastewater from air pollution control devices and solid wastes, such as ash that remains in the combustion chamber and sludge that settles from wastewater treatment operations. Residuals are handled according to applicable waste management regulations. Section V of this PHA presents ATSDR's evaluation of the residuals generated at the TSCA Incinerator.

Those interested in more detailed information on incineration are referred to various documents published by government agencies on environmental health concerns related to thermal treatment technologies (e.g., ATSDR 2002; EPA 1998; NRC 2000).

ATSDR is aware that many parties continue to debate whether incineration is a viable method of waste management. This PHA is not designed to enter this debate. Rather, its purpose is to evaluate the environmental health concerns specific to the TSCA Incinerator at ETTP. It is worth noting, however, that ATSDR has already conducted an extensive public health review of incineration and thermal treatment technologies (ATSDR 2002). That review found that the design and operation of an incinerator (see text box) must be considered when evaluating a particular site. Accordingly, this PHA not only reviews environmental sampling

"Thermal treatment technologies [including incinerators] are inherently neither safe nor unsafe; whether they are safe depends on how they are designed and operated" (ATSDR 2002).

data collected near ETTP, but also considers specific information on how DOE designed and operates the TSCA Incinerator.

II.A.2 Process Description of the TSCA Incinerator

This section describes key elements of the engineering processes at the TSCA Incinerator, focusing on how the engineering design relates to potential air emissions and how waste material passes through the facility. This section provides an overview of the incinerator design, without necessarily identifying and commenting on the countless individual components (e.g., buildings, trailers, tanks, piping, connections) installed at the incinerator. Readers interested in a more detailed account of the engineering design should refer to DOE's permit application for the TSCA Incinerator, which includes highly detailed information about the incinerator design and operation (Radian 1997).

All equipment at the TSCA Incinerator can be classified into five general categories, as shown in Figure 4. The following paragraphs describe the role each category of equipment plays and identify the main air emissions sources from the facility:

- **Waste handling (see box 1 in Figure 4).** The TSCA Incinerator treats solid wastes, liquid wastes, and mixtures of the two. These wastes must be thoroughly characterized before arriving at the TSCA Incinerator, and the facility's environmental permits greatly restrict the types and amounts of waste that the incinerator can treat. EPA and TDEC set these restrictions, commonly referred to as "Waste Acceptance Criteria," based on specific tests demonstrating how effectively the TSCA Incinerator destroys wastes. Refer to Section II.C of this PHA for more detailed information on the Waste Acceptance Criteria.

  Solid wastes arrive at the TSCA Incinerator in enclosed containers, such that dusts or particles cannot blow from the waste material into the environment. Solid waste materials are repackaged into combustible containers, which are kept in storage areas before they are fed to the incinerator. The repackaging occurs over a ventilated table, further reducing the possibility of untreated wastes becoming airborne. Examples of the types of solid wastes processed at the TSCA Incinerator include pallets, spent carbon, used wash rags, filters, trash, and spent personal protective equipment.

  Liquid wastes are stored at the TSCA Incinerator primarily in tanks. While these tanks do have passive vents to the atmosphere, all vapors released from tanks first pass through carbon adsorption filters that capture volatile chemicals which might otherwise enter the air. The liquid wastes are piped directly into the incinerator, either to the rotary kiln or to the afterburner (see below for more information on these operations). With this design, evaporative losses and other fugitive emissions of untreated liquid wastes are expected to be minimal. The TSCA Incinerator is permitted to treat both aqueous waste (e.g., wastewater) and organic waste (e.g., oils, solvent mixtures, degreaser fluids).

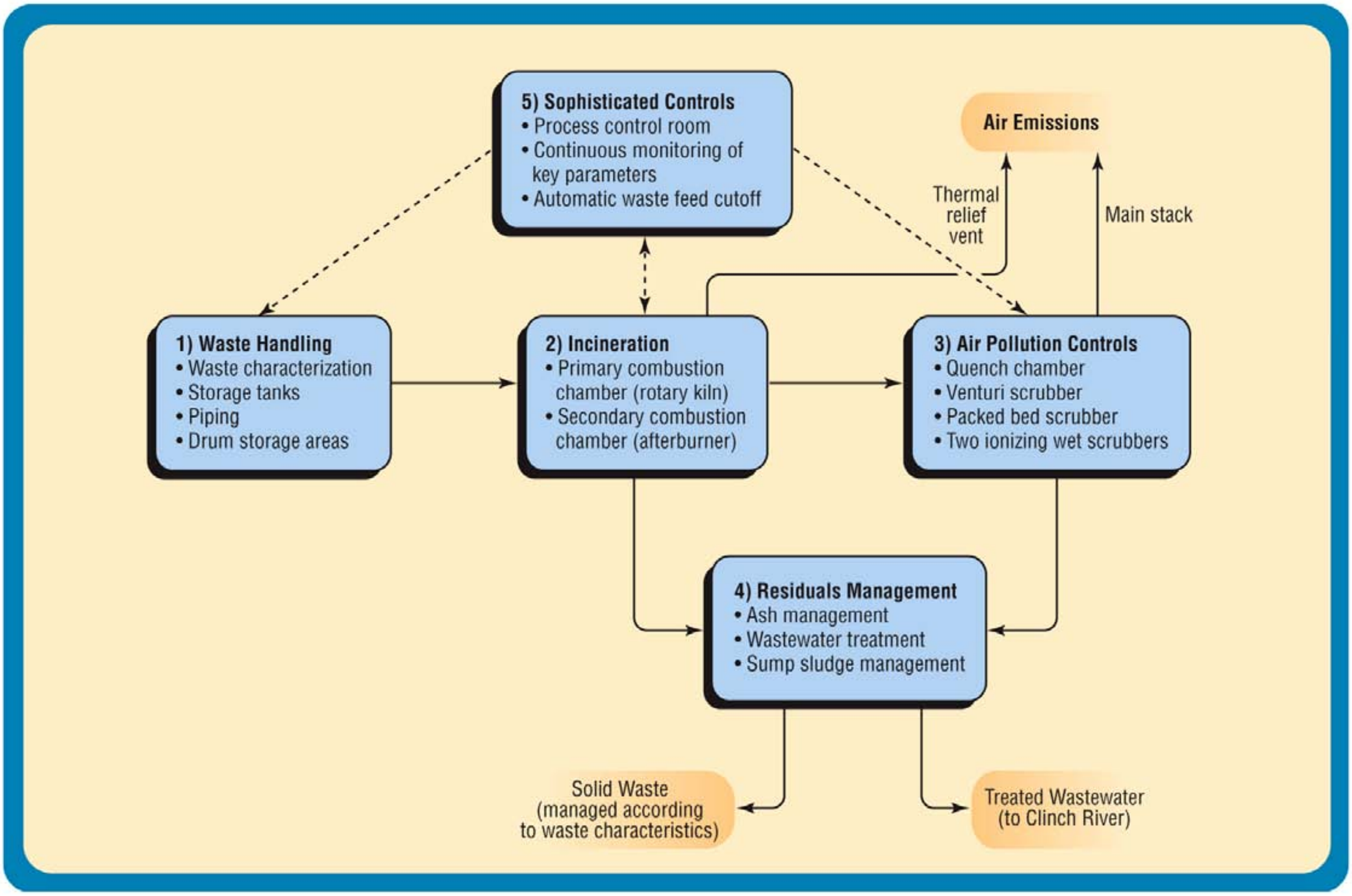


Figure 4. Block Diagram of the TSCA Incinerator

- **Incineration (see box 2 in Figure 4).** The TSCA Incinerator has two combustion chambers in which wastes are burned. The fuel for combustion comes from organic material in the waste itself and from supplemental fuel sources. Natural gas is the primary supplemental fuel used at the TSCA Incinerator, but fuel oil can also be used. Oxygen in air is drawn through the incinerator to support combustion. Further details on the two combustion chambers follow.

  First, all solid waste (along with some liquid waste) is fed into the primary combustion chamber, which is a rotary kiln. The kiln is cylindrical in shape, 6 feet in diameter, and 25 feet long. The inside temperature varies with the type of waste treated, but is generally at least 1,580 degrees Fahrenheit. Incineration of waste in the kiln generates gases which pass into the secondary combustion chamber (see next paragraph) for further treatment. Incombustible material in the waste leaves the rotary kiln in the form of ash. At the end of the kiln, the ash drops into a water pool and enters the residuals management part of the process, as described further below.

  The secondary combustion chamber at the TSCA Incinerator is an afterburner, which serves two general purposes. First, some liquid waste is sprayed directly into the afterburner for purposes of treatment. Second, the afterburner destroys organic material in the gases generated in the rotary kiln. The temperature in the afterburner is typically at least 2,205 degrees Fahrenheit, and gases are exposed to this temperature for at least 4 seconds. With one exception, the treated air stream from the afterburner always passes directly into air pollution controls (see below). As the exception, a thermal relief vent (TRV) on the afterburner opens on infrequent occasions to avoid dangerous buildup of gases and to prevent situations that might harm the downstream air pollution controls. When the TRV opens, the waste feed to the incinerator is instantly cut off, and gases in the afterburner bypass air pollution controls and vent directly to the atmosphere. In the first 14 years that the TSCA Incinerator operated (1991 to 2004), the TRV opened 18 times. Sections III.B.2 and III.D.2 comment further on the significance of the TRV openings.

- **Air pollution controls (see box 3 in Figure 4).** The gases from the afterburner contain a mixture of chemicals (e.g., water, oxygen, carbon dioxide) that, from a health perspective, are relatively benign. But the gas stream also includes trace amounts of toxic contaminants (e.g., acids, metals, radionuclides) from the wastes or that were formed as combustion by-products. Consequently, environmental regulations require most incinerators to have air pollution controls to "clean" their effluents before they are vented to the atmosphere.

  The gases generated in the TSCA Incinerator's afterburner pass through multiple air pollution control devices designed to remove contaminants (primarily particle-bound contaminants and acidic gases) from the effluent stream. The sequence of air pollution controls — a quench chamber, a Venturi scrubber, a packed bed scrubber, and two ionizing wet scrubbers — efficiently removes numerous contaminants, including very fine particles, that would otherwise escape to the air. After passing through these multiple air pollution controls, the process gases are vented to the atmosphere through a 100-foot tall stack.

> As Figure 4 indicates, the main air emissions points from the TSCA Incinerator are (1) routine releases through the main process stack and (2) infrequent non-routine releases through the thermal relief vent. Section III of this PHA evaluates the public health implications of both types of releases.

- **Residuals management (see box 4 in Figure 4).** The main process residuals from the TSCA Incinerator are ash from the rotary kiln, wastewater from the air pollution control devices, and sludge from a water sump. DOE manages all three types of residuals according to applicable permits and waste management regulations.

  Specifically, the wet ash from the water pool at the end of the rotary kiln is transferred via conveyor belt to 55-gallon drums. (Keeping the ash wet minimizes the possibility of wind blowing contaminants into the atmosphere.) Ash samples from the drums are analyzed to determine whether the waste should be disposed of in a landfill or subjected to further treatment. When PCB-containing wastes are being burned, all ash found to contain more than 2 parts per million (ppm) PCBs must pass through the incinerator a second time for further treatment.

  The liquid residuals from the air pollution control devices are collected in a sump, which generates both solid waste (sludge) and liquid waste (wastewater). DOE handles the sludge, similar to the ash, according to applicable solid waste management regulations. The wastewater, on the other hand, is either recycled to the air pollution control devices or pumped to the Central Neutralization Facility (CNF) — the main wastewater treatment plant at ETTP. The treated water is discharged to the Clinch River. DOE's National Pollutant Discharge Elimination System (NPDES) permit requires frequent sampling of the treated water to demonstrate that the effluent will not harm human health or the environment. Refer to Section V of this PHA for ATSDR's evaluation of the environmental health issues associated with the incinerator's residuals.

- **Sophisticated controls (see box 5 in Figure 4).** The TSCA Incinerator has sophisticated controls that help ensure the incinerator efficiently destroys wastes without causing air emissions possibly harmful to health and the environment. These automated controls monitor waste handling operations, incineration, and air pollution controls. Specifically, throughout the TSCA Incinerator process they initiate continuous readings of more than 30 different operating parameters. For instance, temperature in the combustion chambers, waste feed rates, and concentrations of selected gases in the stack exhaust are continuously measured whenever the incinerator operates. Further, the controls quickly shut down incineration operations whenever critical parameters are found to fall outside the TSCA Incinerator's environmental permits. (These shutdowns are more commonly known as automatic waste feed cutoffs, or AWFCOs.) In short, sophisticated automated controls help ensure that the TSCA Incinerator operates safely. Section II.C presents more information on this topic.

The previous discussion highlights general design features of the TSCA Incinerator that are most relevant to environmental releases and to ATSDR's evaluations presented in this PHA. Generally speaking, the incinerator is designed to ensure that organic material in the wastes is efficiently destroyed, with no hazardous residuals generated.

II. B. TSCA Incinerator Operational History

The TSCA Incinerator treats waste material consistently — but not continuously — throughout the year. DOE waste treatment records suggest that the incinerator typically operates up to 250 days per year. Downtime occurs due to various reasons, such as routine or non-routine maintenance.

ATSDR gathered three general types of information to characterize key features of the TSCA Incinerator's operational history:

- **Major permitting milestones (see Table 1).** Table 1 highlights milestones related to the permitting status of the TSCA Incinerator. While this table identifies many key events, it is not intended to be an exhaustive account of the incinerator's entire operational history.

Table 1. Selected Milestones in the TSCA Incinerator's Operational History

Date	Milestone
1984	Construction of TSCA Incinerator begun
May 1988	Final TSCA trial burn prior to permitting
June 1989	Final RCRA trial burn prior to permitting
June 1990	Final state emissions test prior to permitting
April 1991	***Start of routine waste treatment operations at the TSCA Incinerator***
June 1995	Updated state emissions test
November 2000	Updated state emissions test
May 2001	Updated RCRA/TSCA trial burn

Three important observations are evident from the table. First, unlike other emissions sources at ORR that ATSDR has evaluated to date, the TSCA Incinerator has only operated for the past 14 years. Therefore, as Section III explains, this PHA focuses only on potential exposures that have occurred since 1991. Second, the table indicates that DOE performed numerous emissions tests and trial burns before regulatory agencies would permit routine operations. This means that DOE had to characterize thoroughly the incinerator's performance before operations could commence. Third, the table notes that DOE performed several updates to its emissions tests and trial burns. Regulatory agencies required DOE to demonstrate, through these additional tests, that the incinerator continues to meet health-protective requirements specified in environmental permits. Taken together, these observations give some sense of the regulatory oversight of the incinerator's operations, an issue that Section II.C discusses further.

- **Amount of waste treated (see Figure 5).** Between April 1991 and December 2002, the TSCA Incinerator has treated approximately 16,000 tons of waste (DOE 2003a). Over the years, the waste constituents have varied; they typically include a mixture of volatile organic compounds, semi-volatile organic compounds (including PCBs), metals, inorganic compounds, and radionuclides. To illustrate waste-stream variability, the amount of PCBs treated per year has ranged from less than 1 ton to more than 50 tons.

  > The amount of waste that the TSCA Incinerator treats is only a small fraction of the amount allowed under the facility's health-protective permits.

  Figure 5 shows how the annual amount of wastes treated at the TSCA Incinerator has varied from year to year. Waste treatment activity at the incinerator peaked in the mid-1990s and has decreased considerably since then. Not shown in Figure 5 is the fact that the TSCA Incinerator treats only a small fraction of the waste allowed in its environmental permits. Specifically, the current operating permits allow the TSCA Incinerator to treat no more than 1,836 pounds of liquid waste per hour and 964 pounds of solid waste per hour. Given these limits and assuming 10% downtime for routine maintenance, the TSCA Incinerator is currently permitted to treat approximately 10,000 tons of waste per year. Since 2000, however, the amount of waste treated at the TSCA Incinerator has been only 5% of the health-protective permitted limits.

- **Thermal relief vent (TRV) openings (see Table 2).** As noted previously, the TRV on the TSCA Incinerator is a vent that opens to avoid situations where gases in the afterburner might harm or destroy the air pollution control devices. When the TRV is open, gases in the afterburner vent directly to the atmosphere without first passing through the air pollution controls — a situation that has raised concerns among some community members (see Section V). Accordingly, ATSDR obtained information on the history of TRV openings at the facility.

Table 2. History of TRV Openings (1991–2004)

Date	***Cause***	***Ambient Air Sample Analyzed?***
December 20, 1991	Electrical power interruption	Yes
May 5, 1993	Electrical power interruption	Yes
May 6, 1993	False radiation criticality alarm	Yes
February 25, 1995	Electrical power interruption	Yes
May 31, 1995	Electrical power interruption	Yes
June 18, 1995	Electrical power interruption	Yes
December 9, 1995	Loss of TRV magnet	No
December 22, 1995	Loss of programmable logic controller	No
January 28, 1996	Loss of TRV magnet	Yes
January 31, 1996	Loss of TRV magnet	Yes
April 30, 1996	Loss of programmable logic controller	No
July 7, 1996	Loss of TRV magnet	Yes
July 12, 1999	Electrical power interruption	No
December 29, 1999	Loss of programmable logic controller	No
June 29, 2002	Electrical power interruption	No
July 22, 2002	Electrical power interruption	No
February 27, 2004	Electrical power interruption	No
May 13, 2004	Electrical power interruption	No

Source of data: DOE 2003b.

As Table 2 shows, during the first 14 years of the TSCA Incinerator's operations, the TRV was opened 18 times. The most frequent cause of the TRV openings was interruptions to the electrical power system. To minimize the likelihood of power losses shutting down operations, the incinerator is equipped with two separate feeders from the electric switchyard. But power outages have still caused 10 shutdowns (and TRV openings) over a 14-year period. The second most frequent cause was failures in the magnetic latch that keeps the TRV closed. After the last such failure (in July 1996), engineers at the facility designed and installed a new TRV closure mechanism that has addressed this problem (Iglar et al. 1998). The frequency of TRV openings has varied from year to year, with no TRV openings in some years and as many as five TRV openings in others.

To ensure that air releases during TRV openings do not reach unsafe levels, immediately after gases are vented to the air DOE collects air samples at two off-site locations. If waste feed and operating conditions at the time of the TRV opening are not bracketed by those observed during previous events, the samples are analyzed. Table 2 notes that air samples were analyzed for nine out of the 18 TRV openings that occurred between 1991 and 2004.

Section III.D of this PHA reviews the results of samples collected during these episodic releases.

The preceding discussion reviews key observations pertaining to the TSCA Incinerator's operational history. Still, as the next section of this PHA further describes, the facility's environmental permits largely dictate how DOE routinely operates the incinerator.

II. C. Remedial and Regulatory History

DOE could not begin waste treatment operations at the TSCA Incinerator until environmental regulatory agencies, primarily EPA and TDEC, issued the necessary permits. The permitting process for such a facility is quite extensive, as is demonstrated by the fact that more than 2 years passed between the time the TSCA Incinerator was constructed and when permitted operations began. Operations at the TSCA Incinerator must comply with multiple federal regulations (e.g., the Clean Water Act, the Clean Air Act, TSCA, and the Resource Conservation and Recovery Act, or RCRA) and supplemental regulations issued by the state of Tennessee. Further, many activities for operations involving radioactivity must meet standards established by DOE. Although the many permits governing the incinerator's operations address different issues, the environmental permits share one common feature: they are intended to prevent situations in which releases from the TSCA Incinerator can harm human health or the environment.

The remainder of this section reviews notable features of the environmental permits that pertain to environmental releases from the TSCA Incinerator:

- **Waste acceptance criteria.** DOE cannot burn simply any waste in the TSCA Incinerator. Rather, the facility's environmental permits have codes for specific wastes that the facility can treat. Further, the permits establish a Waste Analysis Plan that requires DOE to characterize all wastes sent to the TSCA Incinerator. Under this plan the waste generator must first characterize the chemical composition of waste, typically through rigorous laboratory sampling. The generator could be another department at ETTP, a different ORR facility, or possibly a different DOE facility. After reviewing the waste constituents, operators at the TSCA Incinerator decide whether further waste characterization is needed or whether the waste can be safely treated. Currently, DOE tracks the amounts of more than 250 different constituents in the wastes processed through the TSCA Incinerator (Radian 1997). Ultimately, these waste acceptance criteria help ensure — but do not guarantee — that DOE only accepts wastes the TSCA Incinerator can safely treat.

- **Operating parameters and automatic waste feed cutoffs.** In addition to an incinerator's design, the process operating parameters largely determine the waste destruction and removal efficiency. For instance, waste destruction efficiencies depend on many factors, including the combustion temperatures themselves, how long wastes remain in the combustion chambers, and how well wastes (particularly solid wastes) mix in them. Further, the efficiencies of waste destruction and removal are functions of the ash content in the waste and how the air pollution control devices are operated. The following text box defines the waste destruction and removal efficiency.

What is the waste destruction and removal efficiency (DRE)? The overwhelming majority of waste material fed to an incinerator is not released to the air. Rather, organic chemicals are destroyed in the combustion chambers; metals and radionuclides are largely removed from process streams by air pollution controls and eventually accumulate in solid residuals, whether the ash at the end of the rotary kiln or the sludge from the water used in the air pollution controls.

The destruction and removal efficiency refers to the percent of waste material that is either destroyed or otherwise removed from the waste feed. For most hazardous waste incinerators, DREs for organic compounds are greater than 99.99% and well over 90% for many metals and radionuclides. The DRE for a given chemical is calculated using the following equation:

$$DRE = (\text{Feed Rate} - \text{Emission Rate}) / (\text{Feed Rate})$$

The feed rate is the measured amount of chemical in the wastes fed to the incinerator and the emission rate is the measured amount of chemical in the stack exhaust.

Recognizing that operating parameters are closely linked to incinerator performance, environmental regulatory agencies require thermal treatment facilities to determine, typically through trial burns, the ranges of operating parameters needed to achieve the required destruction removal efficiencies (DREs). For the TSCA Incinerator, DOE had to demonstrate that the incineration process could achieve DREs greater than 99.9999% for PCBs and greater than 99.99% for other organic chemicals expected to be found in hazardous waste. To date, DOE has conducted multiple trial burns at the TSCA Incinerator, all of which have challenged the incinerator to destroy wastes under unfavorable conditions, such as lower combustion temperatures and higher feed rates.

The trial burns conducted at the TSCA Incinerator served two critical purposes. First, they proved that the incinerator could meet the numerous and extensive requirements set forth in environmental regulations, such as minimum DREs and maximum emission rates for certain pollutants. (Appendix A presents detailed summaries of the trial burns conducted at the TSCA Incinerator.) Second, they provided information that regulators could use to establish limits on critical operating parameters. Table 3, for instance, lists several critical operating parameters that DOE must continuously monitor to ensure that the TSCA Incinerator operates in a manner consistent with conditions observed during the trial burns. Whenever operating parameters deviate from the limits shown in Table 3, an automatic waste feed cutoff occurs: the waste feed automatically shuts down, wastes remaining within the incinerator are fully treated, and no further waste is treated until the operating parameters return to acceptable values. Through this continuous monitoring and automatic waste feed cutoff process, regulators help ensure that the TSCA Incinerator only operates in a manner that has been shown to achieve the required waste- destruction efficiencies.

Table 3. Limits Established in Permits for Selected Operating Parameters

Parameter	***Permit Limit***	***Rationale***	***Monitoring Status***
Outlet temperature of rotary kiln	> 1,580 °F	Lower temperatures could lead to more products of incomplete combustion and failure to meet required waste destruction efficiencies for organic wastes.	DOE must monitor all of the parameters listed in this table continuously. Outputs from the monitors are fed directly to the control room. Values found outside of permitted limits will trigger automatic waste feed cutoffs. DOE must frequently test and calibrate the sensors that measure the listed parameters.
Outlet temperature of afterburner	> 2,205 °F		
Gas residence time in the afterburner	> 2 seconds	The afterburner will not destroy organic compounds that move through the system too rapidly.	
Stack exit velocity	< 21.4 feet/second		
TRV opening	Must be closed	Operating with the TRV open would release exhaust gases to the air without first sending them through air pollution controls.	
Concentrations of carbon monoxide in the stack exhaust	<100 ppm (1-hour rolling average)	Higher carbon monoxide levels are an indicator of incomplete combustion or organic material.	
Solid waste feed rate to kiln	<1,008 lb/hour	The trial burns demonstrated that the incinerator can efficiently destroy wastes at these feed rates. Destruction efficiencies at higher feed rates have not been verified.	
Organic liquid waste feed rate to kiln	<812 lb/hour		
Aqueous liquid waste feed rate to kiln	<478 lb/hour		
Organic liquid waste feed rate to afterburner	<710 lb/hour		
Water recycle flow through venturi scrubber	<121 gallons/minute	Values outside these ranges would indicate that the air pollution controls might not be treating the exhaust streams efficiently.	
Effluent pH in the packed bed scrubber	<6.1 (with 30-minute delay)		

Notes:
Source of data: Radian 1997.
The temperature and residence time requirements only apply to TSCA conditions (i.e., incinerating wastes containing PCBs). The RCRA requirements for these parameters are less stringent.
The table lists only a subset of the operating parameters specified in the various environmental permits.

- **Inspections.** The TSCA Incinerator is inspected frequently. For example, TDEC officials typically conduct thorough inspections once a year, during which its representatives observe operations, review records, and interview staff. While inspectors have identified some minor violations of permit conditions, all such violations have been promptly addressed and corrected. Moreover, DOE's environmental permits require extensive self-inspections at regular intervals, ranging from daily to quarterly. These required self-inspections are intended to help DOE identify and promptly correct operational or equipment problems. Taken together, the DOE and TDEC oversight helps minimize the likelihood that critical operational problems at the TSCA Incinerator could go undetected.

- **Other requirements.** The previous discussion reviews some important requirements set forth in the TSCA Incinerator's environmental permits. But this discussion is not exhaustive — the permits require numerous other actions, such as operator training, equipment testing and calibration, emergency planning, and extensive recordkeeping and reporting requirements. ATSDR carefully reviewed these aspects of the environmental permits and generally concurs with the regulatory agencies that the required controls are sufficient (e.g., frequency of equipment testing and calibration is adequate). Moreover, under a recent EPA regulation requiring hazardous waste combustion facilities to implement "maximum achievable control technologies" (MACT) in their processes, the incinerator is now subject to more stringent emissions limits. According to EPA, MACT represents the maximum degree of air emissions reductions that can be realistically achieved, when one considers the available emissions control technologies and their costs and benefits. The MACT standards came into effect on September 30, 2003.

Overall, the purpose of the previous discussion is to emphasize that the TSCA Incinerator is a closely regulated air emissions source. Due to the extensive environmental regulations and permitting requirements, DOE invested considerable effort to obtain its original permits and, to comply with those permits, closely monitors the incinerator's performance.

II. D. Environmental Setting

The environmental setting for a site largely determines how close residents can come to sources of contamination and how contaminants move through the environment. Accordingly, when evaluating environmental health issues for the TSCA Incinerator, ATSDR considered the following observations:

- **Land use.** As noted previously, ETTP is located on approximately 700 acres of land, which is primarily developed for industrial use. According to Figure 2, ETTP lies entirely within ORR, near the westernmost point of the DOE property. The ORR lands surrounding ETTP are largely undeveloped forest areas. Just beyond the ORR boundary near ETTP, some lands have been developed (mostly for light residential, commercial, and agricultural uses), but undeveloped areas are found throughout the Oak Ridge area. The farms in the area produce a variety of products, including beef, dairy, fruits, and vegetables. Home gardens are also present throughout the area. Hunting occurs at many off-site locations, and sometimes even occurs within the ORR boundary — but never within ETTP. Section II.F of this PHA presents detailed information on the residential populations nearest to the TSCA Incinerator.

- **Site access.** ETTP is completely surrounded by a chain-link fence topped with barbed wire. Signs reading "Danger — Unauthorized Personnel Keep Out" are posted at regular intervals along this fence. Only authorized employees and contractors are permitted to enter ETTP and the TSCA Incinerator area, and then only through guarded and gated entries. Visitors are allowed to enter ETTP, but only when accompanied by an escort. Security guard patrols and video surveillance cameras help prevent unauthorized entry to ETTP property. Given these extensive security measures and the extremely low likelihood of trespassers accessing the TSCA Incinerator site, this PHA does not address exposure scenarios for trespassers (see Section III.A). In a response to a community health concern (see Section V), ATSDR does provide insights on exposure scenarios for authorized visitors to the TSCA Incinerator.

- **Terrain.** The TSCA Incinerator is located in a small valley between two ridges (Black Oak Ridge and Pine Ridge) which, like most of the mountain ridges in this area, run from southwest to northeast. Both ridges reach elevations of more than 1,000 feet above sea level, which is approximately 200 feet higher than the base elevation of the TSCA Incinerator. These terrain features are notable because they strongly influence the prevailing wind patterns, which largely determine where any contaminants from the TSCA Incinerator might disperse.

- **Climate and prevailing wind patterns.** The Oak Ridge area has a moderate climate. According to 30 years of data compiled by the National Climatic Data Center, the average annual temperature at Oak Ridge is 68.9 degrees Fahrenheit, with strong seasonal variations. Each year, the area receives approximately 55 inches of precipitation, mostly in the form of rain.

  The prevailing wind patterns in the Oak Ridge area tend to be along the valley floor directions. To illustrate this, Figure 6 summarizes hourly wind speed and wind direction measurements in a format known as a wind rose. The wind rose displays the statistical distribution of wind speeds and wind directions recently observed at a meteorological station located at ETTP. As Figure 6 depicts, the prevailing wind patterns near the TSCA Incinerator are from the southwest to the northeast and, to a lesser extent, from the northeast to the southwest. These directions correspond to up-valley and down-valley flows — directions consistent with local terrain features. Despite the dominance of winds along the valley axis, Figure 6 indicates that winds occasionally blow in other directions. As Section III.D further discusses, when reviewing the ambient air monitoring data and ambient air sampling data for this site, ATSDR focused on exposures that might occur to residents located in the prevailing wind directions, with the understanding that residents who do not live in the prevailing wind directions would experience lower exposures.

- **Surface water.** Precipitation runoff near the TSCA Incinerator either enters storm drains or drains directly into Mitchell Branch, a small stream at ETTP that flows into Poplar Creek. Additionally, wastewater from the TSCA Incinerator, after being treated at the CNF, discharges through a permitted outfall at ETTP into the Clinch River. Therefore, when evaluating potential exposures to water contaminants associated with the TSCA Incinerator, this PHA considers only those exposures that might occur in the Clinch River, at locations downstream from its confluence with Poplar Creek. ATSDR addresses this issue as a community concern in Section V of this PHA.

The previous discussion is intended to identify aspects of the environmental setting that are most relevant to releases from the TSCA Incinerator. Those interested in further information on the environmental setting are referred to other resources (e.g., DOE 1991–2002).

II. E. Local Emissions Sources and Regional Air Quality

Although this PHA focuses on environmental health concerns specific to the TSCA Incinerator, ATSDR identified some general air quality issues for the Knoxville metropolitan area that need to be reviewed to better appreciate the significance of the incinerator's releases. The remainder of this section provides perspective on these related issues, which include other air emissions sources near ETTP (Section II.E.1) and regional air quality concerns (Section II.E.2).

II.E.1. Other Air Emissions Sources

When evaluating the air exposure pathway, ATSDR typically considers not only emissions from the source of concern (in this case, the TSCA Incinerator) but also emissions from other sources in the area. ATSDR takes this approach because community members ultimately are exposed to air contaminants released from all local sources, not just contaminants released from a single source. Accordingly, this section presents information ATSDR gathered on two types of emissions sources near ETTP.

- **Industrial emissions sources.** For insights on industrial emissions sources near ETTP, ATSDR first accessed data from EPA's Toxics Release Inventory (TRI). The TRI reporting regulations require many industrial and federal facilities to disclose annually the amounts of toxic chemicals that they release to the environment and manage as waste. While these regulations do not apply to all facilities or to all possible contaminants (such as radionuclides), the TRI data provide an extensive account of air emissions from industrial sources.

  According to the most recent data available to ATSDR when preparing this PHA, for calendar year 2001 six industrial facilities located within 10 miles of the TSCA Incinerator submitted air emissions data to TRI. Table 4 summarizes the air emissions data that the facilities reported, and Figure 7 shows the locations of these facilities. Two observations can be made from the table: first, the TSCA Incinerator is somewhat isolated from large industrial air emissions sources, as the closest facility that disclosed any air emissions to TRI is 4 miles from ETTP. Second, the TSCA Incinerator accounts for an extremely small fraction (<0.02%) of the total toxic chemicals reported to TRI by other industrial facilities located within 10 miles. Readers should refer to Section V.B of this PHA for further insight on the inferences that should be drawn from the TRI data.

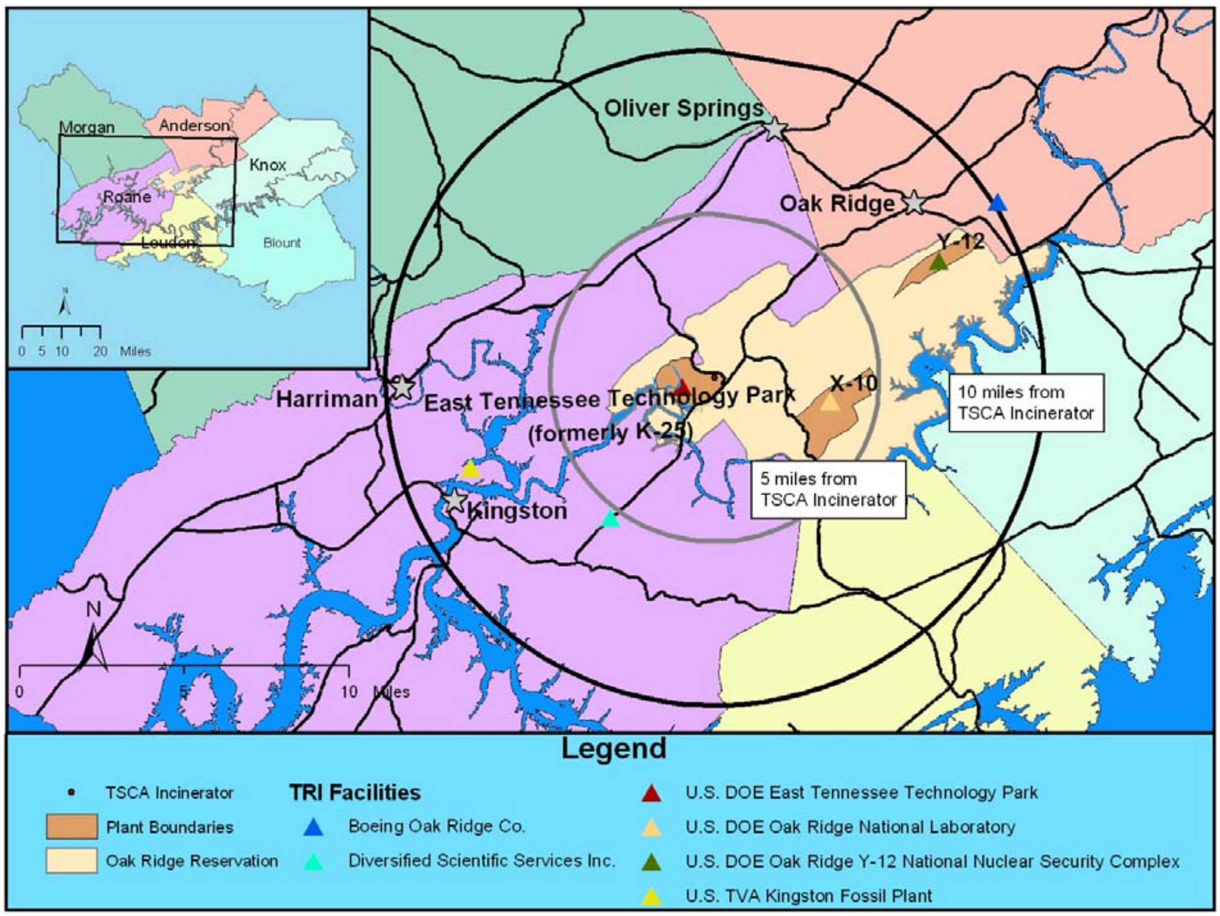
ATSDR is aware that community members have expressed concerns about other air emissions sources more than 10 miles from the TSCA Incinerator. For instance, community members have asked about the significance of TVA's Bull Run Steam Plant, which is located northeast of ORR, about 13 miles from the TSCA Incinerator. In Section V.B of this PHA, ATSDR provides some context on that facility's emissions.

Table 4. Air Toxics Emissions Data from EPA's 2001 Toxic Release Inventory (TRI) for Industrial Facilities within Approximately 10 Miles of ETTP (see notes on following page)

Facility Name	*Approximate Distance from ETTP (See Figure 7)*	*Total Air Emissions of Toxic Contaminants Disclosed to TRI in Reporting Year 2001*
U.S. DOE East Tennessee Technology Park	0 miles	Hydrochloric acid = 25 lbs.
		Lead = 58 lbs.
U.S. DOE Oak Ridge Natl. Lab.	4 miles	Lead = 1 lbs.
Diversified Scientific Services, Inc. (DSSI)	5 miles	Acetonitrile = 14 lbs.
		Methylene chloride = 11 lbs.
		Methanol = 22 lbs.
		n-Hexane = 15 lbs.
		Toluene = 20 lbs.
		Xylenes = 21 lbs.
U.S. TVA Kingston Fossil Plant	8 miles	1,2,4-Trimethylbenzene = 500 lbs.
		Arsenic compounds = 1,505 lbs.
		Barium compounds = 1,250 lbs.
		Chromium compounds = 755 lbs.
		Cobalt compounds = 255 lbs.
		Copper compounds = 755 lbs.
		Hydrochloric acid = 4,000,005 lbs.
		Hydrogen fluoride = 510,005 lbs.
		Lead compounds = 242 lbs.
		Manganese compounds = 1,000 lbs.
		Mercury compounds = 450 lbs.
		n-Hexane = 500 lbs.
		Nickel compounds = 255 lbs.
		Polycyclic aromatic cmpds. = 27 lbs.
		Selenium compounds = 7,705 lbs.
		Sulfuric acid = 1,400,005 lbs.
		Vanadium compounds = 755 lbs.
		Zinc compounds = 255 lbs.
U.S. DOE Oak Ridge Y-12 National Security Complex	8 miles	Freon 113 = 16,530 lbs.
		Hydrochloric acid = 102,332 lbs.
		Lead compounds = 4 lbs.
		Mercury compounds = 2 lbs.
		Methanol = 21,417 lbs.
		Nitric acid = 2,601 lbs.
		Sulfuric acid = 44,221 lbs
Boeing Oak Ridge Co.	10 miles	Nitric acid = 143 lbs.

Notes:
Source of data: EPA 2004a.
Air emissions for ETTP should include amounts of chemicals released from the TSCA Incinerator that are subject to the TRI reporting requirements. The 2001 TRI data for ETTP include forms for PCBs and hexachlorobenzene. However, both forms reported zero air emissions and are therefore not included in the table above.
Data are presented for calendar year 2001. These were the most recent TRI data available when this PHA was first drafted.
The TRI regulations require facilities in certain industries to disclose the amounts of specific toxic chemicals that are released to the environment or managed as waste. However, the regulations do not require that all facilities report, and they do not apply to all toxic chemicals. As a result, this table should not be viewed as a comprehensive inventory of industrial air emissions for the Oak Ridge area. Further, the data in this table likely do not represent all toxic air emissions for the facilities listed. TRI data are self-reported; the accuracy of the release data and the geographic coordinates for individual facilities is not known.

Figure 7. Facilities within 10 Miles of ETTP that Disclosed Air Emissions to EPA's Toxics Release Inventory in Reporting Year 2001



Notes:
Source of data: EPA 2004.
Only facilities that reported air releases to TRI were considered for this figure.
The TRI regulations require facilities in certain industries to disclose the amount of specific toxic chemicals they release to the environment or manage as waste. Still, the regulations do not require that all facilities report, and do not address all contaminants; this is presumably why this figure does not identify every industrial facility in the Oak Ridge area. Therefore, this figure does not present a comprehensive account of industrial air emissions sources near ETTP. TRI data are self-reported; the accuracy of the release data and the geographic coordinates for individual facilities is not known.

- **Other emissions sources.** Recognizing that TRI data characterize air emissions from only industrial emissions sources, ATSDR accessed additional data from EPA's National Emissions Inventory (NEI) — an emissions inventory that accounts for releases from industrial sources, mobile sources, agricultural sources, natural sources, and other types of releases. Table 5 summarizes the most recent NEI data for Roane County for selected criteria pollutants, which are pollutants commonly associated with general air quality concerns. Table 5 clearly indicates that air emissions from ETTP, which include emissions from the TSCA Incinerator, account for an extremely small portion (less than 0.2%) of the county's air emissions of carbon monoxide, nitrogen oxides, particulate matter smaller than 10 microns (PM10), sulfur dioxide, and volatile organic compounds (VOCs). As Section II.E.2 describes further, the data in Table 5 provide important context for two general air quality concerns for the Knoxville metropolitan area.

Overall, the previous discussion reveals that the TSCA Incinerator not only is a relatively isolated source of air emissions, but also appears to account for a small fraction of the total air emissions throughout Roane County and the Oak Ridge area. Consequently, the levels of air pollution measured in the area generally cannot be assumed to result entirely from the TSCA Incinerator. Nevertheless, this PHA thoroughly evaluates the public health implications of all emissions and ambient air sampling data collected for this site, including contaminants (e.g., radionuclides) not typically reported in TRI, NEI, and other emission inventories.

Table 5. EPA's 1999 National Emissions Inventory (NEI) Data for Roane County

Source Category	***Emissions Data for Selected Pollutants***									
	Carbon Monoxide		***Nitrogen Oxides***		***PM10***		***Sulfur Dioxide***		***VOCs***	
	Tons per Year	***% of Total***	***Tons per Year***	***% of Total***	***Tons per Year***	***% of Total***	***Tons per Year***	***% of Total***	***Tons per Year***	***% of Total***
ETTP (includes TSCA Incinerator)	5	<0.1%	30	0.1%	5	<0.1%	1	<0.1%	7	0.2%
Other major industrial sources	1,357	5.1%	26,782	86.8%	5,529	73.0%	110,795	99.6%	267	6.1%
Mobile sources	23,879	88.9%	3,898	12.6%	156	2.1%	221	0.2%	2,350	53.6%
All other sources	1,611	6.0%	153	0.5%	1,883	24.9%	169	0.2%	1,764	40.1%
Totals for Roane County	26,852	100%	30,863	100%	7,573	100%	111,186	100%	4,388	100%

Notes:
Source of data: EPA 2004b.
EPA updates its NEI data every 3 years. Results for 1999 are shown, as that is the most recent year for which final NEI data are available.
Air emissions for ETTP should include releases from the TSCA Incinerator.
The PM10 emissions data shown here include the sum of filterable and condensable particulate matter smaller than 10 microns.
"Other major industrial sources" is the sum of releases EPA has reported for the "major" air emissions sources in Roane County. A "major" source emits a threshold amount (or more) of at least one criteria pollutant; thus, this category includes the largest industrial emissions sources in the county. These include Oak Ridge National Laboratory, U.S. TVA Kingston Fossil Plant, Clinch River Corporation, Horsehead Resource Development Company, and Fortafil Fibers, Inc.
"Mobile sources" include a wide range of on-road and off-road mobile sources that burn gasoline, diesel fuel, and other types of fuels. These emissions sources include automobiles, trucks, and various commercial, industrial, recreational, and agricultural vehicles.
"All other sources" include industrial sources that are not categorized as major sources, residential emissions sources (e.g., fireplaces, wood-burning stoves, trash burning), and miscellaneous other sources (e.g., wind-blown dust, forest fires, structural fires).

II. E. 2. General Air Quality in the Knoxville Metropolitan Area

For more than 20 years, EPA and state environmental agencies have evaluated general air quality concerns by measuring ambient air concentrations of six common air pollutants, also known as criteria pollutants. The criteria pollutants are

- carbon monoxide,
- lead,
- nitrogen dioxide,
- ozone,
- two forms of particulate matter, and
- sulfur dioxide.

Many different air emissions sources contribute to the airborne levels of these pollutants. For every criteria pollutant EPA has established a health-based National Ambient Air Quality Standard (NAAQS). In cases where air quality does not meet an NAAQS, states are required to develop and implement plans to bring air pollution levels into attainment with the health-based standards. The following paragraphs review the general air quality in the Knoxville metropolitan area:[1]

- **Ozone.** Currently, at least eight ambient air monitoring stations throughout the Knoxville metropolitan area measure airborne levels of ozone throughout the summer months. In recent years, ozone levels at several stations exceeded EPA's health-based standards, suggesting that the air quality is at times unhealthy. As a result, the Knoxville metropolitan area is classified as a "non-attainment area" for ozone, and TDEC was required to develop a plan to improve the air quality. Refer to Section V of this PHA for more information on the health implications of exposure to elevated ozone levels.

  The ozone air quality issue in the Knoxville metropolitan area is not unique. In fact, nearly every major metropolitan area along the East Coast has unhealthy ozone levels occasionally during the summer months. Moreover, more than 150 million residents nationwide live in ozone non-attainment areas. It is also important to note that the ozone problems in the Knoxville area are complex and result from industrial and motor vehicle emissions over a broad geographic region. Sources that release nitrogen oxides and VOCs (both known as

> **What is ozone?** Ozone forms in air when emissions from numerous sources, including motor vehicles and industry, mix together and react with sunlight. Ozone levels are typically highest during the afternoon hours of the summer months, when the influence of direct sunlight is greatest. When airborne ozone levels are high enough, people may experience respiratory health problems.

1 For the purposes of this PHA, ATSDR considered the following counties to be part of the Knoxville metropolitan area: Anderson County, Blount County, Jefferson County, Knox County, Loudon County, Roane County, Sevier County, and Union County. This list of counties is based primarily on counties that EPA considered when evaluating the attainment status for 8-hour average ozone concentrations (EPA 2004f) and PM2.5 concentrations (EPA 2004c).

ozone precursors) contribute significantly to ozone formation. As Table 5 shows, the TSCA Incinerator releases relatively small amounts of these precursors, especially when compared to other sources in Roane County and beyond. In short, the Knoxville area's ozone air quality issue is regional in nature and is largely unrelated to air emissions from the TSCA Incinerator. Consequently, this PHA addresses ozone issues in response to community concerns about general air quality (see Section V), and not as a site-specific issue.

What is particulate matter (PM)? PM is airborne particles and droplets of varying sizes and chemical composition. Many different industrial, mobile, natural, agricultural, and other sources release PM directly to the air or release pollutants that form PM while in the air. Environmental regulations have addressed total suspended particulates (TSP), particulate matter smaller than 10 microns (PM10), and particulate matter smaller than 2.5 microns (PM2.5). Section III.D comments further on the different size fractions of PM.

- **Particulate matter.** TDEC and other parties monitor airborne levels of particulate matter (PM) at several locations throughout the Knoxville metropolitan area. Monitoring currently occurs for three different size fractions of PM. While the monitoring data found airborne levels of larger particles (PM10 and TSP) to be safely below EPA's corresponding health-based standards, airborne levels of fine particulates (PM2.5) in Knox County are not. Therefore, Knox County has been designated a non-attainment area for PM2.5. EPA and TDEC are currently deciding which neighboring counties, if any, should be included in this non-attainment area (TDEC 2004; EPA 2004c).

Like the area's ozone problems, the PM2.5 issues in the Knoxville metropolitan area are not unique. According to EPA's most recent estimates, approximately 99 million U.S. residents — mostly in urban areas in the Midwest, northeast, and along the Appalachian Mountains — live in PM2.5 "non-attainment areas." In many cases, the PM2.5 problems cannot be attributed to a single source; PM2.5 forms in the air from many precursors that originate from multiple combustion and industrial sources over broad areas. That said, however, emission inventory data (e.g., Table 5) have shown that the TSCA Incinerator emits insignificant amounts of PM2.5 precursors, particularly when compared to other emissions sources in the Knoxville metropolitan area. Therefore, this PHA addresses the elevated PM2.5 levels in the Knoxville metropolitan area as a regional air quality issue (see Section V), not one resulting from the TSCA Incinerator's emissions.

Airborne levels of ozone and PM2.5 are sometimes unhealthy in the Knoxville metropolitan area. The air quality problems for both pollutants are ***regional issues***—not directly the result of air emissions from the TSCA Incinerator. Section V of this PHA discusses the public health implications of living in areas where airborne ozone and PM2.5 levels are occasionally elevated.

- **Other pollutants.** The Knoxville metropolitan area is considered to be in attainment with the NAAQS for the remaining criteria pollutants: carbon monoxide, lead, nitrogen oxide, and sulfur dioxide. This means that ambient air concentrations of these pollutants are believed to be safely below EPA's corresponding health-based air quality standards. As a result, this PHA does not discuss these pollutants any further.

II. F. Demographics

ATSDR examines demographic data to determine the number of people who are potentially exposed to environmental contaminants and to consider the presence of sensitive populations, such as children (age 6 years and younger), women of childbearing age (between ages 15 and 44 years), and the elderly (age 65 years and older). This section considers general population trends for residents nearest to the TSCA Incinerator and also identifies the residential areas closest to the site.

- **General population trends.** Figure 8 summarizes demographic data for areas within 3 miles of the TSCA Incinerator, based on information compiled in the 2000 U.S. Census. As the figure shows, most areas within 3 miles of the TSCA Incinerator are also within the ORR property boundary, where no one lives. Overall, an estimated 1,224 persons live within 3 miles of the site, and many of these individuals are life-long residents. These individuals live primarily northwest of the site (e.g., in the communities of Dyllis and Sugar Grove) and southwest of the site. The nearest school is approximately 3 miles from the TSCA Incinerator (IT Corporation 2000). According to the Census data, 8% of the population within 3 miles of the incinerator are children, and 11% are considered elderly.

- **Residents closest to the site.** The two residential areas nearest to the TSCA Incinerator are both more than 1 mile from the site. First, several homes and farms, mostly isolated, are located northwest of the incinerator along Blair Road, Sugar Grove Valley Road, Poplar Creek Valley Road, and other streets. The home in this area nearest to ETTP is approximately 1.7 miles from the TSCA Incinerator. Black Oak Ridge, however, separates this entire residential area from the site. This ridge likely limits (but does not prevent) the incinerator's emissions from blowing directly into the residential neighborhoods. Second, additional homes and farms are located southwest of, and across the Clinch River from, the TSCA Incinerator. These homes and farms are along Gallaher Road, Lawnville Road, and side streets of these roads. All residences in this area are at least 2.0 miles from the TSCA Incinerator, but in this case a large ridge does not separate this area from the site.

In addition to the aforementioned residential neighborhoods, where prolonged or chronic exposures to site contaminants are feasible, ATSDR also considered short-term exposures residents might experience when they are closer to the TSCA Incinerator. The nearest publicly accessible area is Blair Road, which at its closest point passes about ¼ mile from the base of the TSCA Incinerator stack. Residents are not expected to spend extended periods of time outdoors on the parts of Blair Road nearest to the TSCA Incinerator, though such activity is not prohibited.

Later sections of this PHA refer to the demographic data. Specifically, Section IV evaluates public health implications of chronic exposure for residential populations, and Section V presents health-related information specific to children and the elderly, which are known to be sensitive to exposures to certain air pollutants.

II. G. Summary of Public Health Activities Pertaining to the TSCA Incinerator

For more than 12 years, ATSDR has been evaluating environmental health issues related to other facilities at ORR. The text box at the end of this section describes how residents can get more information on ATSDR's past and ongoing environmental health activities for those other facilities. A timeline for the main public health activities specific to the TSCA Incinerator follows:

- In May 1997, amid growing community concerns regarding the TSCA Incinerator, the Governor of Tennessee convened an independent panel of environmental scientists, occupational health professionals, and engineers to evaluate DOE's operation of the site. The panel was charged with reviewing the operations and making recommendations to ensure that releases from the incinerator do not harm human health or the environment. The independent panel issued its final report on the TSCA Incinerator in January 1998 (Iglar et al. 1998). The report acknowledges that some workers and community members are sick from undetermined causes, but notes that the incinerator's emissions and local air quality measurements were generally within permissible values.

- In June 1997, TDEC prepared a report to respond to community concerns regarding the TSCA Incinerator (TDEC 1997). The report is titled *Responses to the 101 Questions from Citizens Presented to the Tennessee Department of Environment and Conservation*. While this report does not focus exclusively on public health activities, it addresses a wide range of community concerns related to the operation and oversight of the TSCA Incinerator.

- In August 2003, ATSDR began the public health assessment process for the TSCA Incinerator. In the months that followed, ATSDR obtained and reviewed site documents prepared by numerous parties, including DOE and its contractors, EPA, TDEC, and local community groups. ATSDR contacted these and other parties (e.g., TVA) for access to relevant environmental sampling data.

- After thoroughly evaluating the information gathered to date, ATSDR presented its technical approach for the TSCA Incinerator PHA to community members at the Public Health Assessment Work Group (PHAWG) meeting held on March 15, 2004, in Oak Ridge, Tennessee. During this meeting community members asked ATSDR to address several health concerns specific to the TSCA Incinerator. ATSDR's responses to these concerns are included in Section V of this report.

- In March 2004, a team of ATSDR scientists and contractors, including air quality specialists, conducted a tour of the ETTP site. During the tour, ATSDR viewed the entire TSCA Incinerator process, reviewed selected records and reports maintained at the TSCA Incinerator, viewed meteorological and ambient air monitoring equipment at several locations, and drove around the perimeter of ETTP and through surrounding residential neighborhoods.

- On November 15, 2004, ATSDR presented its preliminary findings on the TSCA Incinerator PHA to community members at the newly formed Exposure Evaluation Work Group meeting. During this meeting, community members identified a few health concerns that had not been communicated to the agency previously. ATSDR's responses to these concerns are included in Section V of this report.

ATSDR will remain involved with the community throughout this public health assessment process. Anticipated future activities include presenting the main findings of the Public Comment Release PHA to the Oak Ridge Reservation Health Effects Subcommittee (ORRHES), obtaining and responding to comments received during the public comment period, and ensuring that the recommended public health actions in the final PHA are implemented.

Where can one obtain more information on ATSDR's activities at Oak Ridge?

In addition to completing this PHA, ATSDR and other agencies have evaluated numerous other environmental health issues related to ORR facilities. Community members can find more information on ATSDR's past activities by:

Visiting one of the records repositories. Copies of ATSDR's publications for ORR, along with publications from other agencies, can be viewed in records repositories at the Oak Ridge Public Library, the DOE Information Center in Oak Ridge, the Tennessee Department of Health, and ATSDR's Oak Ridge Field Office. For directions to these repositories, please contact the ATSDR Oak Ridge Field Office at 865-220-0295.

Visiting the ORRHES or ATSDR Web sites. These Web sites have links to past publications, schedules of future events, and related informational materials. The ORRHES site is http://www.atsdr.cdc.gov/HAC/oakridge and the ATSDR site is http://www.atsdr.cdc.gov. The most comprehensive summary of past activities is available online at http://www.atsdr.cdc.gov/HAC/oakridge/phact/c_toc.html.

Contacting ATSDR directly. Residents can contact representatives from ATSDR directly by dialing the agency's toll-free number, 1-888-42ATSDR (or 1-888-422-8737), or by calling the agency's Oak Ridge Field Office at 865-220-0295.

II. H. Quality Assurance and Quality Control

To prepare this PHA, ATSDR reviewed and evaluated information provided in the documents listed in the References (see Section XII). The environmental data presented in this PHA are from reports produced by many parties, including DOE, EPA, TDEC, and TVA. The limitations of these data have been identified in the associated reports, and, where appropriate, they are restated in this document. After reviewing the studies conducted to date, ATSDR determined that the quality of environmental data available in the site-related documents for the TSCA Incinerator is adequate to support public health decisions. ATSDR has made specific recommendations to improve, or better characterize, the quality of certain environmental sampling efforts. Refer to Appendix C for ATSDR's specific conclusions regarding the quality of the ambient air monitoring and ambient air sampling studies.

ATSDR also used an extensive review process for quality control purposes. Earlier drafts of this PHA and draft findings were presented to numerous parties, including ATSDR scientists with extensive experience in incineration and radiation exposure assessment, DOE, EPA, TDEC, ORRHES, and the PHAWG. ATSDR hopes that this extensive review process has helped ensure that all information and scientific analyses presented in this PHA are scientifically sound and technically accurate.

III. Evaluation of the Air Exposure Pathway

This section presents ATSDR's evaluation of the air exposure pathway for the TSCA Incinerator. The PHA focuses largely on the air exposure pathway because it presents the most likely route by which residents might come into contact with the incinerator's environmental releases. ATSDR considers other exposure pathways (e.g., drinking surface water, contacting soils, eating fish and other locally harvested food items) in Section V of this PHA. Further, ATSDR is currently preparing another PHA that evaluates off-site environmental contamination levels in multiple media, whether that contamination originates from the TSCA Incinerator or from other sources.

This section describes the use of a screening procedure to identify contaminants of potential health concern for the TSCA Incinerator; Section IV then evaluates the public health implications of exposures to those contaminants. This section begins by describing the methodology ATSDR routinely uses to evaluate air exposures (see Section III.A), and then reviews what contaminants have been measured in the TSCA Incinerator's air emissions (see Section III.B), how those contaminants move through the air (see Section III.C), and what levels of contamination have been measured in the local air (see Section III.D). Those interested in only an overview of the air exposure pathway should refer to the summary (see Section III.E), which synthesizes the information on emissions, fate and transport, and ambient air monitoring.

III. A. Introduction

ATSDR's public health assessment process emphasizes the importance of exposure pathways, or the different ways that people can come into contact with environmental contaminants. Analyzing exposure pathways is important because, if residents *are not exposed* to a site's environmental contamination, then the contaminants cannot pose a public health hazard and additional analyses are not necessary. If residents *are exposed* to site-related contaminants, then further analysis is needed to characterize the exposure — that said, however, the fact that exposure occurs does not mean that residents necessarily will have health effects or get sick. In fact, for many contaminants, environmental exposures are often far lower than the exposures people experience through their diets and perhaps through their occupations. In cases where exposures do occur, ATSDR must answer several questions to understand the public health implications:

- To what contaminants are people exposed?
- How often are people exposed, and for how long?
- What are the contaminant levels to which people are exposed?

These are just some of the issues ATSDR considers when assessing whether harmful health effects might result from exposure.

An initial step in the exposure pathway evaluation is clearly defining the issues to be evaluated. As stated previously, this section focuses entirely on the air exposure pathway in order to address the issues of greatest concern to residents. ATSDR has not overlooked the possibility that contaminants released from the TSCA Incinerator might be found in other environmental media (e.g., surface water, groundwater, soil). Rather, ATSDR will consider this possibility in an upcoming PHA that examines an extremely broad data set of recent off-site contamination levels.

Scope of the Air Exposure Pathway Evaluation

Who: What populations are considered in the exposure evaluation? As Section II explains, this PHA addresses exposures that local community members might experience, outside of any ORR-related occupational exposures.

When: What exposure time frame does this PHA consider? This PHA examines exposures only for when the TSCA Incinerator conducted routine operations—1991 to the present. Future exposures may occur as long as the incinerator operates.

Where: Over what area does this PHA evaluate exposures? Modeling studies predict that the highest residential exposure levels to the TSCA Incinerator's emissions are at off-site locations nearest to ETTP, and exposure levels steadily decrease with distance from the site. However, there is no "magic line" that separates exposed and non-exposed populations. This PHA evaluates exposures for locations within 5 miles of the TSCA Incinerator, with the understanding that the highest exposures occur in this area and that all exposures at locations further away are undoubtedly lower.

What: What contaminants does this PHA consider? The PHA examines exposures to contaminants that the TSCA Incinerator likely releases. Emissions from sources other than the TSCA Incinerator are considered in these evaluations, as appropriate, to provide perspective on exposures. Section III.B.1 identifies eight groups of contaminants that ATSDR considers in this PHA.

To define further the air exposure issues for this PHA, ATSDR identified the populations of concern and the time frames, locations, and contaminants of greatest interest. The text box below outlines the scope of the air exposure pathway evaluation.

After establishing the scope of this evaluation, ATSDR used a screening process to identify the contaminants of potential health concern that warrant more detailed consideration (see Section IV). Figure 9 depicts this screening process, in which measured or estimated environmental contamination levels — in this case, ambient air concentrations and radiation levels — are compared with medium-specific comparison values. Comparison values are developed from the scientific literature concerning exposure and health effects. To be protective of human health, most comparison values have safety factors built into them. For some contaminants, the safety factors are quite large (a factor of 100 or greater). As a result, contamination levels lower than their corresponding health-protective comparison values are generally considered to be safe and not expected to cause harmful health effects. But the opposite is not true: contamination levels greater than comparison values are not necessarily harmful. Rather, contaminants found above comparison values require a more detailed toxicologic or radiologic evaluation. In short, ATSDR uses health-protective comparison values to identify contaminants of potential health concern, which require more detailed evaluations (see Section IV) to assess the public health implications of exposure. Appendix D defines the specific comparison values used in this PHA.

The remainder of this section draws from emissions studies, air dispersion modeling studies, and ambient air monitoring or ambient air sampling studies to identify contaminants released by the TSCA Incinerator and to select contaminants of potential health concern. Section III.E summarizes the findings of this exposure pathway evaluation.

III. B. Emissions: What Contaminants Are Released to the Air?

Since 1991, DOE and other parties have compiled extensive information on the amounts of air pollutants that the TSCA Incinerator releases. This section reviews that information, both for stack emissions (Section III.B.2) and for fugitive emissions (Section III.B.3). As noted earlier in this PHA, stack emissions from the TSCA Incinerator are air releases through confined streams, specifically the main stack and the TRV. "Fugitive emissions" refers to all other releases, such as passive venting, wind-blown dust, and evaporative losses. Before reviewing information on stack and fugitive emissions, this section first identifies eight groups of contaminants that hazardous waste incinerators commonly release. The analyses throughout this PHA focus entirely on these groups of contaminants.

This section then reviews emissions data primarily to identify contaminants released from the incinerator. ATSDR typically does not base conclusions on emissions data alone — air emissions disperse considerably between their sources and the locations where people might be exposed. For this reason, ATSDR's environmental health conclusions are based on a combined assessment of emissions data, fate and transport studies, and ambient air monitoring and ambient air sampling studies.

III. B. 1. Groups of Contaminants to Evaluate

Incinerators release many different contaminants into the air. These include typical combustion by-products, products of incomplete combustion, and incombustible materials in the waste stream. The emission rate of a given contaminant typically varies with time and depends on the composition of waste material being treated, the incinerator's operating parameters, and the effectiveness of air pollution controls. Multiple federal agencies have published review documents evaluating general public health issues for incineration facilities and identify contaminants that tend to be of greatest concern (ATSDR 2002; EPA 1998; NRC 2000). Using information in these review documents, ATSDR identified eight groups of contaminants to evaluate in this PHA. Table 6 identifies these groups, defines what contaminants fall into them, and explains how they relate to the TSCA Incinerator. The analyses that follow are organized around these contaminant groups.

Groups of contaminants ATSDR evaluated. This PHA evaluates the public health implications of exposure to the following eight groups of contaminants:

1. Particulate matter
2. Volatile organic compounds
3. Polychlorinated biphenyls
4. Metals
5. Acidic gases
6. Dioxins and furans
7. Polycyclic aromatic hydrocarbons
8. Radionuclides

Taken together, these groups include more than 500 individual contaminants. Refer to Table 6 for more information on these groups.

1 **Table 6. Contaminant Groups Evaluated in this PHA**

Group Name	*Contaminants within the Group*	*Relationship to Incineration Facilities*
Particulate matter	PM2.5, PM10, TSP	Virtually all combustion processes generate airborne particles and droplets. Air pollution controls at the TSCA Incinerator remove most particulate matter from the air exhaust, but some particulates are released.
VOCs	Numerous organic compounds with low molecular weight and high volatility	Waste feeds at the TSCA Incinerator, especially the liquid feeds, contain many VOCs. While the incineration process efficiently destroys most VOCs in the waste feed, trace amounts might pass through untreated. Incomplete combustion might generate trace amounts of other VOCs.
PCBs	209 individual chemicals, known as PCB congeners, that share a common chemical structure	PCBs are found in liquid and solid waste feeds to the TSCA Incinerator. Although the incinerator must destroy more than 99.9999% of the PCBs in these feeds, trace amounts might pass through the incinerator untreated. PCBs are not combustion by-products.
Metals	Numerous elements which, when pure, conduct heat and electricity and are generally hard and strong	Metals pass through incineration processes untreated., either into the residuals (e.g., ash) or into the air emissions. Though air pollution controls at the TSCA Incinerator remove considerable amounts of metals from the air exhaust, some metals from the waste feed do pass into the air untreated.
Acidic gases	Multiple inorganic compounds, such as hydrogen chloride and hydrogen fluoride	Acidic gases form in nearly all fuel and waste combustion processes, including incineration. The TSCA Incinerator's air pollution controls remove over 99% of hydrogen chloride in the process gas stream.
Dioxins and furans	210 individual chemicals, known as congeners, that share some common chemical structures	Dioxins and furans form in processes that burn mixtures containing both chlorine and organic material. Incinerator and air pollution control design can greatly reduce, but not eliminate, formation and release of dioxins and furans.
PAHs	Numerous organic compounds characterized by having multiple aromatic rings	The TSCA Incinerator likely destroys PAHs in the waste feed efficiently. Most PAHs in air emissions likely result from incomplete combustion of organic materials in the waste feeds.
Radionuclides	Unstable or radioactive forms of any element	The waste feed to the TSCA Incinerator contains radionuclides, which pass through the combustion chambers untreated. The radionuclides leave the facility either in residuals (e.g., ash) or in air emissions. Air pollution controls remove most radionuclides from the gas stream, but trace amounts do pass through the entire process and vent into the air.

2 Note: In this PHA, the term "dioxins" refers to the group of chemicals known as chlorinated
3 dibenzo-p-dioxins, and "furans" refers to the group of chemicals known as chlorodibenzofurans.

4

III .B. 2. Stack Emissions

Since 1988, DOE and its contractors have conducted numerous studies to measure both how efficiently the TSCA Incinerator destroys wastes and how much contamination the site releases into the air. The following discussion summarizes the available information on the TSCA Incinerator's emissions, first for routine releases through the main process stack and then for episodic releases through the TRV:

- **Routine releases through the main stack.** DOE and its contractors, under EPA and TDEC oversight, have measured emission rates from the TSCA Incinerator using three types of studies: trial burns, performance tests, and continuous emissions monitoring. Appendix A defines the different types of test and presents ATSDR's detailed reviews of the studies conducted to date.

  Table 7 summarizes key findings of the stack emissions tests and reveals two notable findings. First, the table shows that emission rates have been measured for all eight groups of contaminants that ATSDR is evaluating in this PHA. While some groups of contaminants have been studied more extensively than others, there are no notable data gaps in terms of the contaminants that have been considered. Second, the final column in Table 7 indicates that the measured emission rates generally met permitted limits, in cases where such limits have been established. As the exceptions, a small fraction of the measured emission rates for particulate matter have exceeded permitted limits, and some stack gas concentrations for semi-volatile metals (cadmium and lead) in 2000 and 2001 exceeded technology-based (i.e., not health-based) emissions standards that EPA would later establish in MACT standards. Fortunately, fairly extensive ambient air monitoring data are available for these contaminants. As Section III.D details, those ambient air monitoring data indicate that off-site airborne levels of particulate matter, cadmium, and lead have always been below levels of health concern, despite the fact that emission rates and stack gas concentrations have occasionally exceeded permitted limits or emissions standards.

1 **Table 7. Emissions Data Available for the Groups of Contaminants**

Contaminant Group	*Air Emission Rates Measured Using:*			*Overall Findings*
	Trial Burns	*Performance Tests*	*Continuous Sampling*	
Particulate matter	√	√	√	The overwhelming majority of tests, but not every test, have shown compliance with permitted limits for stack gas concentrations and emission rates. In addition, an extremely large volume of ambient air monitoring is available to support health conclusions on particulate matter (see Section III.D). Continuous emissions monitoring is about to begin.
VOCs	√			No permit limits are available for individual VOCs. Conclusions are based on dispersion modeling analyses (see Section III.C).
PCBs	√			Both trial burns showed that the incinerator's DRE for PCBs is higher than the required limit (99.9999%). Modeling estimates (see Section III.C) and monitoring data (see Section III.D) for PCBs were also considered.
Metals	√	√	√	All tests conducted since the incinerator began routine operations have shown compliance with health-protective *emissions* limits for beryllium, lead, and mercury. *Stack gas concentration* limits have consistently been met for mercury and low-volatile metals (arsenic, beryllium, and chromium). In 2000 and 2001, some stack gas concentrations for cadmium and lead exceeded limits that EPA would later establish in MACT standards. ATSDR used an extensive database of ambient air monitoring results to evaluate the metals further (see Section III.D, Appendix A.3).
Acidic gases	√	√		Every measured emission rate of hydrogen fluoride and hydrogen chloride to date has been at least an order of magnitude lower than the corresponding permitted emission limits.
Dioxins and furans	√			Stack gas concentrations of dioxins and furans have always been lower than levels set in the recent emissions standards. Ambient air monitoring data for dioxins and furans were also reviewed (see Section III.D).
PAHs	√			There are no permit limits for individual PAHs. Conclusions are based on dispersion modeling analyses (see Section III.C).
Radionuclides			√	There are no permit limits for individual radionuclides. Conclusions are based on dispersion modeling analyses (see Section III.C) and ambient air monitoring data (see Section III.D).

2 Notes: Refer to Appendix A for detailed reviews of the trial burns, performance tests, and continuous emissions monitoring at the
3 TSCA Incinerator.

- **Episodic releases following TRV openings.** As Table 2 of this PHA notes, on 18 occasions between 1991 and 2004, the TRV at the TSCA Incinerator opened. These openings prevent high-temperature gases from damaging air pollution controls or harming employees, but they also result in afterburner gases briefly venting into the atmosphere without first passing through air pollution controls.

  Emission rates have never been measured during times when the TRV is open. Measuring such emissions presents several logistical challenges. For instance, specialized equipment would be necessary to sample releases, given that afterburner gases would likely be at temperatures (>2,200 degrees Fahrenheit) that would damage conventional stack testing equipment. Further, field personnel who sample air in close proximity to such high-temperature gases face very serious health and safety issues. Finally, the short time scales of TRV releases present difficulties — many EPA stack testing methods require sampling of at least an hour's duration to get adequate sample volumes. For these reasons, ATSDR is not convinced of the feasibility of measuring emission rates when the TRV is open, especially considering that DOE already collects ambient air samples at upwind and downwind locations during these times. Refer to Section III.D for ATSDR's review of the ambient air sampling that has occurred during the TRV events.

In summary, DOE has extensively characterized routine emissions through the incinerator's main stack. In reaching health conclusions for the TSCA Incinerator, ATSDR considered the measured emission rates, along with findings from the fate and transport and ambient air monitoring studies. ATSDR does not view the absence of measured emission rates for TRV openings as a critical data gap, given the fact that air samples are collected during all TRV events and that the events occur so infrequently.

Residents are not exposed directly to the incinerator's emissions. ATSDR reviews emissions data to better characterize what is released. Air monitoring data (see Section III.D) offer the best insights into airborne contamination levels that people might breathe.

III. B. 3. Fugitive Emissions

Measuring fugitive emission rates is inherently difficult, considering that industrial facilities' releases can occur from numerous locations. The exact amount of fugitive emissions from the TSCA Incinerator is not known, but two observations suggest that the amount is relatively low. First, DOE is required to implement a fugitive emissions monitoring program, in which periodic measurements of organic vapors are taken throughout the facility to ensure that process leaks and other fugitive emissions sources are identified and promptly controlled. Second, the following facility design features help minimize fugitive emissions:

- The entire incinerator operates under negative pressure, which helps prevent vapors and dusts from blowing out of the incineration process.
- Liquid wastes are handled in a manner that minimizes releases of untreated wastes. For instance, the wastes that arrive in tank trucks, are pumped into storage tanks in closed systems. Further, all organic liquid storage tanks have vents equipped with carbon adsorption units that help prevent VOCs from evaporating directly into the atmosphere and prevent

releases during tank loading operations. The carbon adsorption units have breakthrough indicators that give advance warning of when the units need to be changed. Facility personnel inspect the breakthrough indicators daily.

- All ash generated in the rotary kiln is discharged into water in the ash sump, which greatly reduces the amount of ash that might otherwise blow into the air.

Combined, these observations suggest that the fugitive emissions are minimal, though the exact amount of fugitive emissions remains unknown. The independent panel of experts chartered by the Governor of Tennessee reached a similar finding regarding the TSCA Incinerator's fugitive emissions (Iglar et al. 1998).

ATSDR does not view the lack of quantitative fugitive emissions data as a critical data gap — the extensive ambient air monitoring data and ambient air sampling data for this site (see Section III.D) characterize the air quality impacts from all local sources of emissions, including the fugitive emissions from the TSCA Incinerator.

III. C. Fate and Transport: How Do the Contaminants Move through the Air?

> Dispersion models estimate air quality impacts from an emissions source based on a scientific understanding of how contamination moves through the air. The models can only estimate ambient air concentrations, and these estimates may understate or overstate actual air quality impacts. The accuracy of modeling outputs largely depends on the scientific rigor of the model itself and the quality and representativeness of model input parameters.

ATSDR identified two air dispersion modeling studies of the TSCA Incinerator's emissions. The independent panel chartered by the Governor of Tennessee conducted one study (Iglar et al. 1998) and DOE conducted the other (DOE 1997–2002). To address limitations in these studies, ATSDR conducted an additional modeling evaluation. Appendix B presents detailed reviews of these three modeling studies.

The independent panel's modeling study concludes that the incinerator's air quality impacts are greatest at locations southwest and northeast of the TSCA Incinerator. This finding is not surprising, given the prevailing wind patterns and local terrain features. The exact point of maximum impact was predicted to be 0.4 miles southwest of the stack, at a location within ETTP (Iglar et al. 1998). ATSDR used modeling results predicted at this on-site location to identify contaminants of concern. This approach is believed to be health-protective because the maximum air quality impacts found within ETTP are higher than the incinerator-related impacts that most residents experience, whether for short-term or long-term exposures.

Table 8 outlines key findings from the three modeling studies reviewed in this PHA. While detailed reviews of the individual studies are in Appendix B, several general observations should be noted. First, between the three modeling studies, all eight groups of contaminants of interest for the TSCA Incinerator were evaluated, leaving no notable data gaps. Second, with one exception addressed below, the modeling for every contaminant group found that estimated annual average ambient air concentrations were lower than health-based comparison values. In the cases of particulate matter, most VOCs, PCBs, acidic gases, dioxins and furans, and PAHs, the estimated concentrations were all more than 100 times lower than the corresponding health-based comparison values. While ATSDR acknowledges that modeling analyses such as these have inherent uncertainties, these analyses appear to be scientifically sound and to offer reasonable accounts of the incinerator's air quality impacts (see Appendix B). Of course, no air dispersion model is perfect; for this reason, ATSDR carefully reviewed the extremely large volume of ambient air monitoring data (see Section III.D) for this site to assess the accuracy of the modeling estimates. Overall, the information in Table 8 suggests that the TSCA Incinerator's air emissions do not cause residents to be exposed to unhealthful levels of air contaminants, at least over the long term.

Three additional comments on the modeling analyses deserve mention. 1) all of the modeling studies considered for this PHA predicted ambient air concentrations representative of chronic exposures as a result of routine stack releases, and did not consider potential acute exposures nor non-routine releases through the TRV. ATSDR's review of ambient air sampling data during TRV events (see Section III.D) provides perspective on the acute exposure scenarios that appear to be of greatest concern. 2) the extensive ambient air monitoring data (see Section III.D) for many of the contaminants, especially particulate matter, metals, and radionuclides, compensates for any inherent uncertainties in the modeling analyses. 3) using the independent panel's modeling analysis, ATSDR selected chromium as a contaminant of concern. This selection was made due to the lack of information on the relative amounts of trivalent and hexavalent chromium in the ambient air. Section IV.C of this PHA revisits this issue.

Table 8. Fate and Transport Modeling Results Available for the Groups of Contaminants

Contaminant *Group*	***Modeling Evaluation Conducted by:***			***Overall Findings***
	Governor of Tennessee's Independent Panel	***DOE***	***ATSDR***	
Particulate matter	√			The estimated annual average concentration of particulate matter at the point of maximum impact was 0.067 µg/m³ — considerably lower than both EPA's health-based air quality standards and the levels of airborne particulate matter routinely found in this part of the country.
VOCs	√		√	The TSCA Incinerator efficiently destroys VOCs. Even at the point of maximum impact, the estimated VOC concentrations were mostly three orders of magnitude below health-based comparison values.
PCBs	√		√	Modeling conducted by both the independent panel and ATSDR found that estimated ambient air concentrations of PCBs from routine operations are more than 1,000 times lower than health-based comparison values, even for the year when the greatest amount of PCBs was processed.
Metals	√			Chromium was selected as a contaminant of concern, but estimated air concentrations of all other metals were safely below health-based comparison values.
Acidic gases	√		√	Estimated ambient air concentrations of acidic gases are more than 400 times lower than their corresponding health-based comparison values.
Dioxins and furans			√	Estimated ambient air concentrations of dioxins and furans are immeasurably low, even at the point of maximum impact, where exposure concentrations are more than 100 times lower than health-based comparison values for cancer effects.
PAHs			√	ATSDR's modeling analysis of emissions data collected during a recent trial burn suggests that the highest annual average concentration of total PAHs (0.000005 µg/m³) is far below levels of health concern, even if one conservatively assumed that only the most toxic PAH is present.
Radionuclides		√		DOE has estimated (using an EPA-approved model) that, in all years during which the TSCA Incinerator operated, air emissions of radionuclides from the entire ORR cause an effective dose equivalent to the maximally exposed resident of less than 1.7 mrem/year — a dose far below health-protective values established in EPA regulations. Extensive ambient air monitoring data are consistent with this estimated dose.

Notes: Appendix B reviews the three modeling evaluations listed above and identifies additional modeling studies that have been conducted.
Modeling addressed releases from routine operations. See Section III.D for ambient air sampling results during non-routine releases (i.e., TRV events).

III. D. Ambient Air Monitoring and Ambient Air Sampling: What Are the Levels of Air Contamination?

This section reviews the results of ambient air monitoring and ambient air sampling studies, or studies that measure contamination in the air that people breathe. Studies conducted by DOE, EPA, and TDEC weighed heavily in the conclusions ATSDR developed for this PHA. In response to a community concern, ATSDR also obtained and reviewed data compiled by TVA, but those data were not collected to assess air quality impacts from the TSCA Incinerator. Appendix C presents ATSDR's detailed reviews of the relevant ambient air monitoring and ambient air sampling studies.

Terminology. In the field of air pollution, *ambient* air generally refers to outdoor air that people might breathe. Ambient air is commonly measured by equipment placed at a fixed outdoor location.
Ambient air monitoring differs from air sampling in that *monitoring* typically implies periodic measurement of air contamination levels. Monitoring provides useful insights on how air quality changes over the long term.
Air *sampling*, on the other hand, generally refers to air quality measurements of discrete events, such as a TRV opening.

Across all the studies conducted to date, an extremely large volume of ambient air monitoring and ambient air sampling data are available to characterize the TSCA Incinerator's air quality impacts. These data span the entire time frame during which the TSCA Incinerator has operated (1991 to the present), have been collected in locations believed to have the greatest air quality impacts, and have thoroughly characterized ambient air concentrations for multiple contaminant groups, especially particulate matter, metals, and radionuclides.

Both ambient air monitoring and ambient air sampling measure airborne contamination levels. But it is important to remember that measured concentrations reflect contributions from all nearby emissions sources and some distant ones. Thus, even though monitoring and sampling studies have been designed to characterize air quality impacts from the TSCA Incinerator, the air contamination levels measured do not necessarily originate only from the incinerator. ATSDR's interpretations throughout this section are sensitive to this issue. Nonetheless, the public health evaluations presented in this PHA are ultimately based on the measured air contamination levels that people might inhale, regardless of the source or sources believed to account for most of the contamination.

Table 9 gives an overview of the air quality measurements available for the eight groups of contaminants evaluated in this PHA. The remainder of this section provides more detailed summaries of the relevant air quality measurements collected both during routine operations at the TSCA Incinerator (see Section III.D.1) and during episodic releases, mainly TRV openings (see Section III.D.2). ATSDR used these measurements to characterize potential chronic and acute exposures to incinerator emissions.

Table 9. Ambient Air Monitoring and Ambient Air Sampling for the Groups of Contaminants

***Contaminant** Group*	***Study Conducted by:***			***Overall Findings***
	DOE	***EPA***	***TDEC***	
Particulate matter	√			DOE has collected more than 2,000 particulate matter samples, both PM10 and TSP, at or near ETTP since the TSCA Incinerator first began operating. Every measured concentration and every annual average concentration has been well below EPA's corresponding health-based air quality standards.
VOCs				VOCs have not been measured in any studies at ETTP. However, air dispersion modeling studies estimated the incinerator's likely incremental impacts on airborne VOC levels: these air quality impacts were consistently more than 100 times lower than levels of public health concern.
PCBs	√			Routine PCB monitoring has not occurred, but DOE has measured PCB concentrations during TRV events, when emissions might be expected to peak. Even the highest total PCB concentration recorded during a TRV event (0.00082 $\mu g/m^3$) is well below health-based comparison values.
Metals	√		√	DOE has routinely monitored ambient air concentrations of metals since the TSCA Incinerator first processed wastes, and TDEC has conducted side-by-side monitoring to verify that DOE's monitoring results are valid. Combined, these measurements suggest that airborne levels of arsenic, cadmium, and chromium require more detailed evaluations. Section IV.B of this PHA assesses the public health implications of exposure to these contaminants.
Acidic gases				Although acidic gases have not been measured in any of the ambient air monitoring or ambient air sampling studies, estimated air concentrations of hydrogen chloride and hydrogen fluoride were both more than 400 times lower than levels of public health concern, even at the point of maximum air quality impacts.
Dioxins and furans	√			Like PCBs, dioxins and furans have not been monitored routinely near the TSCA Incinerator, but they have been measured during TRV events. The measurements did not find contamination to be at levels of health concern, especially considering the limited exposure durations for these events.
PAHs				Although PAHs have not been measured in any of the ambient air monitoring or ambient air sampling studies, ATSDR's air modeling study found incinerator-related air quality impacts from PAH emissions to be orders of magnitude below health-based comparison values.
Radionuclides	√	√	√	DOE, EPA, and TDEC have all conducted extensive monitoring near the TSCA Incinerator for ambient levels of radiation and radionuclides. This monitoring, which is continuous and has spanned almost the entire duration of TSCA Incinerator operations, has shown that concentrations of radionuclides are considerably lower than corresponding health-based comparison values.

Notes: Refer to Appendix C for detailed reviews of the ambient air monitoring and ambient air sampling results listed in this table.
Modeling addressed releases from routine operations. See Section III.D for ambient air sampling results during non-routine releases (i.e., TRV events).

III. D. 1. Measurements During Routine Operations

The following paragraphs briefly review the results of the ambient air monitoring that DOE, EPA, and TDEC have conducted during the TSCA Incinerator's routine operations. For three out of the eight groups of contaminants that ATSDR is evaluating, over the last 15 years an extremely large volume of air quality measurements have been made . While Appendix C describes detailed features of the individual monitoring efforts, the following paragraphs (and Table 9) highlight notable trends across the studies:

- **Particulate matter.** Between 1991 and the present, DOE has collected more than 2,000 valid 24-hour average particulate matter samples, both as PM10 and TSP. The samples were collected using appropriate methodologies and sampling schedules, and the measured concentrations appear to be of a known and high quality. The samples were collected at numerous locations around ETTP (see Figures C-1 and C-2), including locations where dispersion models predicted maximum ground-level impacts from the TSCA Incinerator. Every single 24-hour average PM10 and TSP concentration measured to date has been below EPA's corresponding health-based air quality standards, and the annual average concentrations calculated from these individual measurements have also been below appropriate health-based standards. Additionally, the monitoring data did not reveal any pronounced spatial variations in particulate matter concentrations. In short, DOE has compiled an extremely extensive data set on particulate matter over the entire history of the TSCA Incinerator's operations, and the measured PM10 and TSP concentrations have not reached levels of health concern.

- **Metals.** As Appendix C describes in greater detail, both DOE and TDEC have measured ambient air concentrations of metals at multiple locations around the TSCA Incinerator. DOE has monitored airborne metals since the TSCA Incinerator first operated, and TDEC has done so for the last 7 years. Both parties' monitoring considered the same set of seven metals. Of these, beryllium, lead, nickel, and uranium had no concentrations greater than health-based comparison values. On the other hand, arsenic, cadmium, and chromium all had annual average concentrations greater than health-based comparison values (using a comparison value for hexavalent chromium to screen the chromium concentrations). The measured levels for these three metals did not exhibit notable spatial variations across the monitoring stations, suggesting that no single emissions source contributes most to these metals' ambient air concentrations. Nonetheless, ATSDR selected arsenic, cadmium, and chromium as requiring further evaluation. Section IV evaluates the public health implications of exposure to these metals in greater detail.

  When reviewing air quality measurements for metals, ATSDR identified several opportunities for improving and enhancing the existing ambient air monitoring networks. First, ATSDR noted that a stated purpose of TDEC's monitoring program is "to provide an independent verification of monitoring results as reported by the DOE" (TDEC 1996–2002). ATSDR agrees that this is an important objective. Given that DOE and TDEC now operate metals sampling equipment at the same locations, TDEC should be able to perform a quantitative verification of the sampling results, consistent with the program goals. But no detailed data comparisons were documented in the site reports that ATSDR reviewed. Recognizing that independent co-located measures of the same air contaminants provide an excellent opportunity for verifying the quality of DOE's metals data, ATSDR has recommended that TDEC conduct such an analysis and document findings in a future annual environmental report (see Section IX).

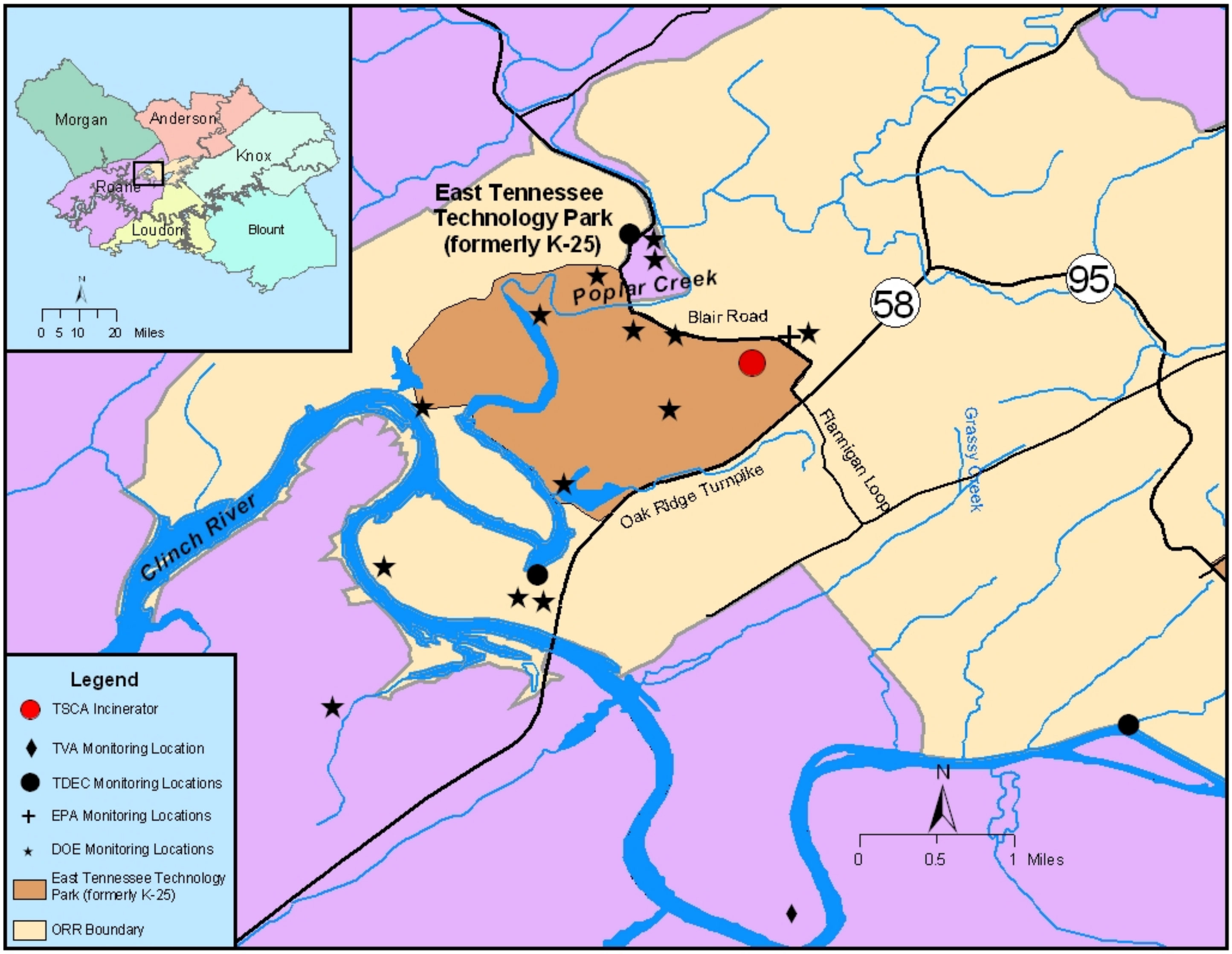
ATSDR was prepared to conduct its own comparison of DOE's and TDEC's ambient air monitoring data for metals, but could not do so due to how the two agencies' annual environmental reports present metals data. Although general trends in the two data sets appear to be consistent, a quantitative comparison is impossible because the annual reports do not document detection limits and sometimes aggregate monitoring data from multiple stations into area-wide averages. Because these and other reporting practices limit the utility of the measurement results, ATSDR has recommended several improvements to the data presentation in DOE's and TDEC's annual environmental monitoring reports. Section IX of this PHA lists these recommendations.

Some data trends illustrate potential conflicts between data reported by DOE and TDEC. In DOE's monitoring, both arsenic and cadmium apparently were detected in an overwhelming majority of air samples. In TDEC's monitoring, on the other hand, these metals appear to have been detected infrequently. This apparent conflict is best explained by the use of analytical methods with differing sensitivities. TDEC currently uses an analytical method with detection limits ranging from 0.001 to 0.01 $\mu g/m^3$, while the method DOE uses achieves much lower detection limits. ATSDR has recommended that TDEC's monitoring network use a more sensitive analytical method, such that the agency can independently verify the accuracy's of DOE's monitoring data.

- **Radionuclides.** From at least 1991 to the present, DOE's environmental surveillance network has included perimeter monitoring at the main ORR facilities. At ETTP, for instance, DOE has operated two perimeter monitoring stations to measure airborne concentrations of radionuclides in air masses before they blow into nearby communities. DOE's monitoring has considered numerous gamma-emitting radionuclides, including those found to account for the highest portion of the effective dose equivalent at off-site receptors attributed to the TSCA Incinerator's air emissions (see Appendix B.2). The radionuclides reported most frequently were isotopes of beryllium, cesium, cobalt, potassium, thorium, and uranium. As Appendix C.1 documents in detail, DOE's continuous ambient air sampling never detected these and other radionuclides at levels greater than health-based comparison values (i.e., DOE's derived concentration guides). More importantly, even the highest annual average concentration measured was more than 100 times lower than levels of potential health concern.

  In addition to DOE's monitoring efforts, EPA has continuously sampled air for radionuclides at ETTP, but this sampling did not commence until 1996. EPA's sampling device is installed at DOE's K-2 station (see Figure 10), approximately ¾-mile from one of DOE's perimeter monitoring stations. As the text box below indicates, there is reasonable agreement between DOE's and EPA's measurements for uranium isotopes, especially considering that the monitoring devices are not co-located. Also encouraging is the fact that both networks reported a similar relative abundance across the different uranium isotopes.

Figure 10. Locations of Ambient Air Monitoring and Ambient Air Sampling Stations



> Overall, both DOE and EPA have conducted extensive and continuous sampling for airborne radionuclides at locations downwind from the TSCA Incinerator. Both sets of monitoring results show that exposures to airborne radionuclides, even at the location believed to be most impacted by incinerator emissions, are well below levels of potential health concern. Also significant is the fact that the independent data measures are reasonably consistent, which suggests (but does not prove) that neither set suffers from serious data quality problems.

In summary, ambient air monitoring data for particulate matter, metals, and radionuclides have been collected in multiple locations around ETTP over the entire history of the TSCA Incinerator's routine operations. While the available data do not characterize all eight contaminant groups considered in this PHA, they do quantify air quality impacts for three groups of contaminants that incinerators cannot destroy. Section III.E describes how ATSDR factored trends and patterns among the ambient air monitoring data into the overall air exposure pathway evaluation.

III.D.2. Measurements During Episodic Releases

The chief episodic releases of concern for the TSCA Incinerator are those that occur during TRV events — gases that have passed through the afterburner are vented directly to the atmosphere without first passing through air pollution controls. It is important to note, however, that the waste feed to the TSCA Incinerator immediately shuts down when TRV events occur, thus minimizing the potential air quality impacts during these episodes.

As Table 2 indicates, 18 TRV events occurred between 1991 and 2004, and DOE collected and analyzed valid air samples at two locations during 9 of these events. The sampling locations are located southwest and northeast of the TSCA Incinerator, and therefore lie in the path of the prevailing winds. Currently, DOE evaluates the circumstances surrounding each TRV event to determine whether off-site ambient air samples should be analyzed. For instance, DOE could judge that analyzing samples is not necessary if a TRV event occurs when small quantities of wastes are being processed or if a previous sampling event already characterized the anticipated air quality impacts. Following is a summary of the monitoring data that have been collected to date:

- **PCBs.** The highest ambient air concentration of total PCBs measured during a TRV event was 0.000817 $\mu g/m^3$. This concentration was measured on June 18, 1995, when a power outage shut down the incinerator operations. This concentration is more than 10 times lower than the most protective health-based comparison value. Therefore, ATSDR concludes that exposure to even the highest PCB concentration measured during TRV events would not cause adverse health effects, especially considering the limited duration of exposure.

- **Dioxins and furans.** The highest ambient air concentrations of total dioxins and total furans measured during TRV events were 0.00000223 $\mu g/m^3$ and 0.00000593 $\mu g/m^3$, respectively. Evaluating these exposure concentrations is complicated — no health-based comparison values have been published for "total dioxins" or "total furans."

  As an alternate approach to assessing these concentrations, ATSDR compared the highest measured values to the range of background concentrations reported for the ETTP area (DOE 2003b). According to sampling that occurred while the TSCA Incinerator was down, background total dioxin levels near ETTP range from 0.000000774 to 0.00000416 $\mu g/m^3$, and the highest measured dioxin concentration during a TRV event falls within this range. ATSDR notes that the range of background concentrations reported for ETTP is reasonably consistent with ranges of background concentrations that have been reported for other parts of the country (ATSDR 1998). Therefore, even the highest dioxin concentration measured during a TRV event does not appear to be unusually elevated. Given this observation and the extremely short exposure duration, ATSDR believes that the measured concentrations are not at levels of health concern and do not warrant further evaluation.

For total furans, the highest measured concentration during a TRV event is actually three times greater than the upper bound of the background measurements made at ETTP (DOE 2003b), but furan levels during the other TRV events were generally consistent with background levels. After review of an evaluation of the highest likely acute exposures, ATSDR does not view this lone detection above background levels as being of public health concern. Although very limited information is available on health effects in humans or animals after inhalation exposure to furans (ATSDR 1994), ATSDR has published a minimal risk level (MRL) for acute ingestion exposures to a potent furan congener. The acute ingestion MRL is 0.001 µg/kg/day. By definition (see Appendix D), this MRL is an ingestion dose likely without an appreciable risk for adverse non-cancer effects following a short-term exposure. For a typical adult (who weighs 70 kg), this acute MRL would represent an approximate ingestion intake of 0.07 µg/day. During the TRV openings, however, the highest likely inhalation intake is approximately 0.000047 µg/day.2 Therefore, the highest inhalation intake that an individual might have reasonably experienced during TRV openings is nearly 500 times lower than the ingestion intake associated with the acute ingestion MRL. This large margin provides some confidence that acute furan exposures during TRV openings are not associated with adverse health effects. As Section IX of this PHA notes, ATSDR recommends that DOE continue to collect ambient air samples during TRV openings to ensure that these events do not cause residents to be exposed to harmful levels of air pollutants.

- **Radionuclides.** As noted previously, DOE and EPA have radionuclide monitoring stations downwind of the TSCA Incinerator that continuously sample air. Although this sampling cannot quantify the short-term incremental air quality impacts associated with TRV events, releases during these events are accounted for in the long-term average measurements. Therefore, the monitoring data for radionuclides outlined in the previous section implicitly account for contamination released during the infrequent TRV events.

In summary, DOE has analyzed ambient air samples during half of the TRV events that occurred between 1991 and 2004. These data suggest that ambient air concentrations of PCBs, dioxins, and furans are not unusually elevated following these events, especially when compared to background levels. This observation, combined with the infrequent nature of the events and their short duration, implies that air quality impacts during TRV openings are negligible. Given the limited evidence of short-term air quality impacts during these events, ATSDR does not believe it necessary to collect air samples for the remaining groups of contaminants (e.g., particulate matter, VOCs, metals, acidic gases, PAHs) during future TRV openings.

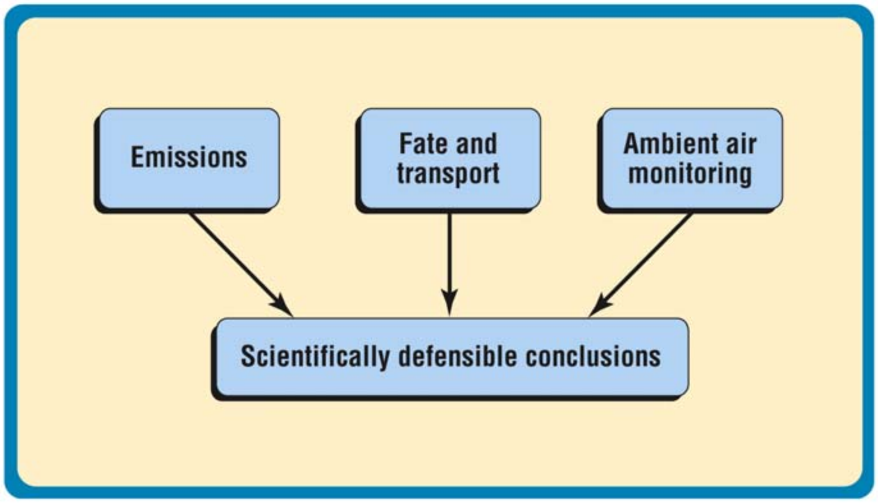
III.E. Synthesis of Information

This entire section has focused on evaluating three critical elements of the air exposure pathway: emissions, fate and transport, and ambient air monitoring. One must consider all three elements in order to have a complete understanding of the air quality issues surrounding the TSCA Incinerator (see Figure 11).

---

2 This intake was calculated by multiplying the highest furan concentration (0.00000416 µg/m^3) by an inhalation rate for adults engaged in heavy activities (3.2 m^3/hour, from EPA 1997) and by an estimated exposure duration (8 hours). These assumptions likely represent the highest possible exposures during a TRV opening.

Figure 11. Synthesizing Information for the Air Exposure Pathway



The following discussion integrates the information presented above in an attempt to answer key questions: Is there enough information on the contaminant group to reach conclusions? Is the information in the available studies consistent? Are more detailed analyses required for any contaminants? Is further sampling needed for any of the contaminants? ATSDR's evaluation of these issues for the eight groups of contaminants follows:

- **Particulate matter.** More than 2,000 air samples for particulate matter have been collected at multiple locations around ETTP over the entire history that the TSCA Incinerator has operated. All of the sampling results are safely below EPA's corresponding health-based air quality standards. Consistent with these data are findings from the independent panel's modeling analysis, which predicted that the incinerator's particulate emissions would have limited air quality impacts at downwind locations. Further, nearly every stack test and trial burn conducted to date has found particulate matter emissions at levels below limits set in environmental permits. All these observations provide compelling evidence that the TSCA Incinerator does not emit particulate matter at levels expected to cause adverse health effects among residents.

- **VOCs.** During the RCRA trial burns, DOE demonstrated that the TSCA Incinerator destroys more than 99.99% of organic compounds in the waste feed. Further, continuous emissions monitoring for carbon monoxide and carbon dioxide provides a real-time indicator of how efficiently the incinerator is burning wastes. To evaluate potential air contamination levels, both the independent panel chartered by the Governor of Tennessee and ATSDR estimated VOC air concentrations using modeling techniques. Both modeling studies concluded that none of the VOCs released by the TSCA Incinerator are likely to ever exceed health-based comparison values. While ATSDR acknowledges that the modeling analysis has inherent uncertainty, the estimated concentrations for every VOC considered were more than 1,000 times lower than health-based comparison values. This ample "margin of safety" provides ATSDR some reassurance that small modeling uncertainties do not have a significant bearing on the conclusion that the incinerator's emissions of VOCs are not at levels of health concern.

- **PCBs.** Every TSCA trial burn conducted to date has demonstrated that the incinerator destroys more than 99.9999% of the PCBs in the waste feed. Thus, for every 1,000,000 pounds of PCBs fed to the incinerator, less than 1 pound of PCBs is released to the air, assuming that the TSCA Incinerator consistently achieved the required DRE. For insights into potential air quality impacts, the independent panel's modeling study predicted that the maximum annual average PCB concentration at ETTP would be 0.000003 $\mu g/m^3$, which is more than 3,000 times lower than the most protective health-based comparison value. Given this large margin, ATSDR is confident in concluding that PCB exposures are not of public health concern. The sampling data collected during TRV openings provides further evidence that the incinerator's PCB emissions do not cause significant air quality impacts at off-site locations.

- **Metals.** Incinerators cannot destroy metals. Any metals fed to incinerators will either be released to the air or captured in process residuals (e.g., ash, sludge, wastewater). Both DOE and TDEC have conducted extensive ambient air monitoring for metals, which has more than adequate spatial and temporal coverage for reaching public health conclusions. Trends among the data suggest that ambient air concentrations of arsenic, cadmium, and chromium warrant further evaluation, while concentrations of beryllium, lead, nickel, and uranium are safely below health-based comparison values. These findings are reasonably consistent with the independent panel's modeling results. Refer to Section IV for ATSDR's evaluation of exposures to metals and to Section IX for suggested improvements to the metals sampling in the existing ambient air monitoring networks.

- **Acidic gases.** Ambient air concentrations of acidic gases have never been measured in the vicinity of the TSCA Incinerator. However, every measured emission rate of hydrogen fluoride and hydrogen chloride to date has been at least an order of magnitude lower than the corresponding permitted emission limits. Further, the highest concentrations of acidic gases (hydrogen chloride and hydrogen fluoride) estimated in ATSDR's modeling evaluation were more than 400 times lower than the chemicals' corresponding lowest health-based comparison values. ATSDR believes these observations sufficiently support the conclusion that the TSCA Incinerator does not release acidic gases at levels expected to harm off-site residents.

- **Dioxins and furans.** To date, all measured emission rates for dioxins at the TSCA Incinerator have met limits set in environmental permits and regulations. ATSDR evaluated potential air quality impacts in a modeling evaluation that considered the highest dioxin emission rate during a recent trial burn. This modeling estimated an annual average dioxin concentration at the point of maximum ground-level impacts, which lies within ETTP property, to be 3.75×10^{-10} $\mu g/m^3$ (on a TEQ basis). This estimated concentration, besides being immeasurably small and likely impossible to differentiate from background levels, is more than 100 times lower than the risk-based concentration of the most toxic dioxin congener. The dioxin levels measured during TRV events are also indistinguishable from background. For these reasons, ATSDR concludes that the air emissions of dioxins need not be evaluated further in this PHA.

- **PAHs.** ATSDR's modeling evaluation provides the best available information on potential exposures to PAHs from the TSCA Incinerator. Using PAH emission rates measured during a recent trial burn and a dispersion factor reported by the Governor of Tennessee's independent panel, ATSDR estimated that the incinerator's air emissions could cause annual average ambient air concentrations of total PAHs to increase by 0.000005 $\mu g/m^3$. Even if one assumes that the total PAHs consist entirely of the most potent individual compound, the estimated increase in concentration is more than 150 times lower than the corresponding risk-based concentration. ATSDR believes this information is a sufficient basis for conclusions for three reasons: 1) the emission rate used in the modeling analysis is expected to overstate air quality impacts, because it was measured during a trial burn that challenged the incinerator with the maximum allowed waste feed rate; 2) the estimated air concentration occurs at a location within the ETTP property, and off-site concentrations would be expected to be lower; and 3) an ample margin of safety separates the estimated concentration from the health-based comparison value.

- **Radionuclides.** Like metals, radionuclides pass through incinerators untreated. Most are captured in process residuals, but some are released to the air. To characterize the impacts of these releases, DOE has been continuously sampling ambient air for radionuclides at the ETTP perimeter since the TSCA Incinerator began operating. To date, the highest annual average concentrations for every radionuclide measured are more than 100 times lower than DOE's health-protective derived concentration guides (see Table C-3). Additionally, for the last 8 years, EPA has continuously sampled air for radionuclides at a point directly downwind from the TSCA Incinerator. EPA's measured concentrations are very consistent with DOE's, providing greater confidence that both programs are generating high-quality data. These trends, combined with extensive radiation dose modeling DOE conducts in fulfillment of regulatory requirements (i.e., NESHAPs), strongly suggest that the TSCA Incinerator's air emissions do not cause unsafe exposures to radiation or radionuclides. Given that incinerators do not destroy radionuclides (and the level of community concern regarding potential exposures), ATSDR has recommended, as a prudent public health measure, that DOE and EPA continue monitoring ambient air concentrations of radionuclides into the future.

Referring to the previous discussion, ATSDR concludes that further analyses are needed to evaluate the public health implications of exposures to arsenic, cadmium, and chromium. For all other metals and groups of contaminants, the studies that have characterized emissions, fate and transport, and ambient air monitoring clearly show that the TSCA Incinerator's air emissions do not cause residents to be exposed to unhealthful levels of air contaminants.