GUIDANCE TO ATSDR HEALTH ASSESSORS

PUBLIC HEALTH OVERVIEW OF INCINERATION

AS A MEANS TO

DESTROY HAZARDOUS WASTES

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FOREWORD

This document states the views and policies of the Agency for Toxic Substances and Disease Registry (ATSDR) on use of temporarily-sited incinerators to destroy hazardous wastes. The document is intended for use by ATSDR's health assessors and regional staff when responding to questions about public health implications of the incineration of hazardous wastes. The views contained in the document are meant to address public health issues sometimes voiced to ATSDR by state and local health agencies and the general public in connection with incineration of wastes. As such, the document is not meant to replace or modify materials used by other government agencies charged with the responsibility to determine actions on management of hazardous wastes.

Although this document deals with incineration of hazardous wastes, the reader is cautioned that ATSDR's acceptance of incineration of hazardous substances is contingent on consideration of all remedial alternatives for a site. That is, **each remedial alternative, including incineration of hazardous wastes, must be evaluated for its potential to affect public health.** Moreover, the selection of a particular remedial action at a site resides with federal and state regulatory agencies that must consider public health implications along with other risk management considerations.

Although ATSDR has public health authorities under both the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, and the Resource Conservation and Recovery Act (RCRA), as amended, this document pertains only to incineration actions proposed or taken under CERCLA. Therefore, **ATSDR's comments in this document pertain only to the temporarily-sited incinerators that are to be used to remediate sites under CERCLA.**

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INTRODUCTION

The Agency for Toxic Substances and Disease Registry (ATSDR) receives questions from health professionals in state and local health agencies and from the public regarding human health implications of hazardous waste incineration. Because health studies of populations living near incineration facilities are few, the Agency cannot answer many of those questions.[1] Also, because incinerators are often located in industrial areas, it would be difficult or impossible in many instances to attribute any observed health effects to one source of emissions. For example, there may be power plants, materials production plants, commercial cleaning facilities, or other establishments whose Toxic Chemical Release Inventory data suggest the facilities have the potential to impact local air quality.

However, the better Agency staff understand the characteristics of a well-designed and properly operated hazardous waste incinerator, the better ATSDR can provide informed advice about public health implications. **The purpose, therefore, of this document is to provide ATSDR staff an overview of the current engineering practices of incineration and their relationship to public health concerns regarding actual or potential contaminant releases associated with the technology.**

ATSDR's Division of Health Assessment and Consultation maintains additional materials to help public health assessment personnel evaluate the public health implications of hazardous waste incineration. For a representation of the kinds of reference materials maintained by ATSDR, see the references used for this overview and the list of Environmental Protection Agency (EPA) guidance documents in Table 3.

BACKGROUND

As a matter of general public health policy, ATSDR supports waste minimization, recycling, and reuse as the preferred methods for reducing the volume of hazardous wastes and associated public health hazards. However, the Agency recognizes that not all hazardous waste can be eliminated and that wastes need proper management and disposal. In some situations, such as the

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[1]It should be noted that ATSDR has undertaken two health studies of communities near incinerators; one in Jacksonville, Arkansas, near an incinerator used for cleaning up a Superfund site; the other in Lenoir, North Carolina, near an incinerator that was closed by the local county health officer because of alleged improper operation.

remediation of hazardous waste at Superfund sites, a review of all remedial technologies may indicate the use of mobile incinerators as the preferred method of permanently eliminating or reducing potential public health hazards posed by those wastes. **ATSDR believes that a properly designed and operated incinerator can effectively destroy certain kinds of hazardous wastes in a manner that is protective of public health.**

The EPA is responsible for selecting and implementing remedies for cleanup of Superfund National Priorities List (NPL) sites. EPA's selection of incineration as the remedy of choice for some sites has led to an increased number of requests to ATSDR for health information related to incineration. When selected as a site remedy, incineration should be conducted in a manner that protects human health.

ATSDR does not participate in the actual site remedy selection decision, or any engineering or monitoring decisions; however, it is ATSDR's responsibility to advise on the public health implications of the technology, as needed, when proposed for or used at NPL sites. Many of the requests for assistance ATSDR receives are related to the transportable incinerators used for site remediation. In response to such requests, **it is ATSDR's policy to review site-specific design and operating detail sufficiently to assess actual and potential contaminant releases posed by the facility.** That policy is consistent with the source evaluation phase of the ATSDR public health assessment protocol.

Some of the information in this overview also may be applicable to other kinds of incinerators that public health assessors may be required to review, i.e., permanent municipal and medical waste incinerators; however, ATSDR staff are strongly cautioned against applying the findings in this paper to other than CERCLA incinerators.

INCINERATOR DESIGN AND OPERATING CONSIDERATIONS

The goals of the modern hazardous waste incinerator are to reduce or destroy the organic contaminants, and to reduce the volume of waste materials, thus minimizing the amounts of potentially hazardous substances needing final disposal. To achieve those goals, the incinerator must be able to provide controlled burning (combustion) conditions that ensure the proper mixture of air, temperature, and gas, and time to allow thorough destruction of organic constituents to take place. A deficiency in any of those requirements can result in incomplete combustion and the production of smoke and possibly harmful air emissions. **Such emissions are a potential public health hazard because nearby communities may be exposed to site contaminants via the air transport pathway.** It should also be recognized that human

exposure to airborne incinerator contaminants can occur indirectly by consumption of animals or plants raised in areas where deposition of emissions takes place (1).

In addition to the potential health hazard to communities from air emissions of hazardous substances, the design and operation of an incinerator have implications for the workers at the facility. Inadequate work practices and poor industrial hygiene conditions at an incinerator have the potential to cause adverse health effects in workers.

In striving for hazardous waste incineration performance that protects both human health and the environment, EPA has established operating and performance standards based on research and trial burn data. The EPA hazardous waste incineration regulations are found in 40 CFR Part 264, Subpart O. The hazardous waste regulations developed under the Resource Conservation and Recovery Act (RCRA) are commonly called the RCRA regulations. The standards are designed to limit emissions of certain pollutants to EPA-specified acceptable levels. Emission standards have been set for particulates, hydrogen chloride, and principal organic hazard constituents (POHCs).

The EPA standards for particulates (0.08 grains per dry standard cubic foot corrected to 7% O_2) and hydrogen chloride (4 pounds per hour or 99% removal) are generic and apply uniformly to all hazardous waste incinerators. EPA has also developed a number of guidance documents used by RCRA permit writers and by CERCLA staff to evaluate hazardous waste incinerators (See Table 3). Those documents specify how to apply the generic regulatory standards on a site-specific basis. The more recent guidance documents recommend limiting emissions of certain metals, products of incomplete combustion, and carbon monoxide. The public health assessor should obtain a copy of the operating conditions specified by CERCLA, as well as any amendments to those documents for the incinerator being evaluated. Those documents can be used to determine and evaluate the operating conditions and emission limits that have been applied to the incinerator during specific time periods.

Principal Organic Hazard Constituents (POHCs)

Also as a part of the hazardous waste incinerator permitting process, certain constituents of the wastes, or POHCs, and operating conditions are selected for trial burns. Trial burns are conducted to demonstrate an incinerator's performance under the worst conditions that would be allowed during future routine operations. POHCs are selected based on their degree of toxicity, their prevalence in the waste mix, and/or their difficulty to burn. A new incinerator must demonstrate, through

trial burns, that it can successfully meet all emission standards. For POHCs, that standard is a destruction and removal efficiency (DRE) of at least 99.99%. That means that no more than 0.01% of the selected POHC compounds fed into the incinerator may be emitted to the atmosphere. If polychlorinated biphenyls (PCBs) or dioxins are to be burned, the DRE requirement is 99.9999%.[2] When individual states are authorized to administer hazardous waste incineration regulations, such regulations must be at least as stringent as those issued by EPA.

Products of Incomplete Combustion (PICs)

When hazardous waste or virtually any other material is burned, products of incomplete combustion (PICs) can be formed (2,3). PICs can be partial breakdown products from the waste being burned, or they can be new species of compounds formed by the recombination of other breakdown products. PICs can be relatively harmless, or they can be even more toxic than the parent compounds of the waste fed to the incinerator. Benzo-a-pyrene and 2,3,7,8-tetrachlorodibenzo-p-dioxin are examples of potentially harmful PICs that may be emitted if an incinerator is inadequately designed or improperly operated.

The public and the regulatory community alike are concerned about PIC emissions, particularly because they are difficult to predict and, therefore, to regulate. In an attempt to address that concern, EPA researched the formation of PICs during test burns conducted at hazardous waste incinerators throughout the United States, and at incinerators used strictly for research. Testing was done under steady-state (normal) and upset operating conditions. Using test burn findings, EPA states that, if the incinerator is meeting the stack emission requirements, particularly the CO limit of 100 parts per million by volume, available field test data show that PIC emissions are limited to concentrations that do not pose unacceptable risks (4). That position is founded upon cancer-based health risk assessments for identified PICs. It should be noted that although research has not identified all PICs, and other potential health outcomes (non-cancer) have not been thoroughly evaluated, the evaluation of cancer risks typically results in allowable exposure levels

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[2]PCBs are regulated by EPA under the Toxic Substances Control Act (TSCA). Most PCB incinerators co-burn hazardous wastes; therefore, the other operating and performance standards discussed in this section also apply to the incinerator. It should be noted, however, that, if the incinerator burns only PCBs, only the TSCA regulations apply, and the permit may not be as comprehensive as a RCRA permit. This overview does not address differences between RCRA and TSCA regulations.

much lower than would be allowed for non-cancer health outcomes. Because there is no recognized threshold exposure level for the cancer health outcome, even extraordinarily low exposures to carcinogenic substances are assumed to pose some risk of cancer. In order to keep that risk at an acceptable level (usually one cancer in a lifetime per 100,000, or one million, exposed individuals), only very low exposure levels are allowed by regulatory agencies.

For organics of particular concern, or for inorganic contaminants such as metals, hydrogen chloride, or chlorine, emission limits can be formulated specifically for the incinerator and the geographic area of concern. The EPA guidance manuals recommend that such limits be based on anticipated stack releases of the particular contaminant (usually worst case), local meteorologic conditions, geographical site features, and proximity to local populations (4,5). It should be noted that such conditions have been included in RCRA guidance manuals only since the late 1980s. The public health assessor should review the CERCLA contracts, in effect at each facility to determine what the potential emissions may be.

Ash

Another public health concern that citizens often raise about hazardous waste incineration pertains to disposal of ash generated by the process (6,7). By definition, such ash is considered hazardous waste and must be managed as such in a permitted hazardous waste treatment, storage, or disposal facility, such as a permitted hazardous waste landfill. If EPA can be shown that the ash is nonhazardous, the ash can be disposed of in a licensed municipal waste landfill. Minimally, evidence would have to be provided showing that the ash is not corrosive, reactive, or flammable, and that it will not release water-soluble toxic substances, such as heavy metals, to groundwater or surface waters, at levels above EPA levels of concern.

Design Considerations

To minimize the public's potential exposure to site emissions, an incinerator must be designed and operated properly. What constitutes a state-of-the art, well designed, and properly operated incinerator? The incinerator must be designed to burn waste materials thoroughly (8). The combustion chambers must be of a size and arranged in a way to provide adequate time for the gases produced by burning waste to mix with proper amounts of combustion air, and to maintain the high temperatures needed to ensure that the burning is completed. When an incinerator is designed, the waste to be burned must be characterized for such

properties as heat content (fuel value), percent moisture, chlorine content, metals content, and physical characteristics. The size and physical layout of the incinerator should be based on those waste properties.

The incinerator must be designed and operated in a manner that minimizes production of non-stack, fugitive emissions. That can be accomplished by ensuring proper seals at all system connections, maintaining negative gas pressures throughout the combustion gas flow path, and by limiting the waste feed to prevent excessive and rapid releases of volatile compounds. Careful attention must also be given to the design and operation of waste handling systems to minimize fugitive emissions. ATSDR public health assessors have found that excavation and handling of soils at some Superfund sites, and waste unloading and repackaging operations at some RCRA facilities, have been major sources of airborne contaminants that have resulted in exposure of workers and/or nearby residents.

Another critical part of the incinerator design is the pollution control system (9). Pollution control systems directly influence the levels and kinds of pollutants that are released and that can potentially reach the public. Most modern hazardous waste incinerators are designed with extensive air pollution removal systems. For example, a common pollution control system might include a system that cools or "quenches" gases produced by burning waste, followed by a system that reduces acid gas emissions, and ultimately followed by a particulate removal system such as fabric filters (baghouses), electrostatic precipitators, venturi scrubbers, and others.

Finally, current design of hazardous waste incinerators includes various safeguards, such as process monitoring devices (to monitor parameters such as temperature, air flow, and operating pressures); continuous emissions monitoring systems (to measure air emissions of carbon monoxide, gas flow rates, and possibly other combustion performance indicators); and automatic waste feed shutoff devices (AWFSOs). AWFSOs, as required by RCRA regulations (40 CFR 264.345(e)), automatically stop the waste feed to the incinerator when specified monitoring parameters exceed or fall below limits specified in the permit. The parameters that trigger the AWFSOs are established based on successful trial burns. AWFSOs are critical to ensuring that the incinerator cannot operate in an improper condition -- with attendant increased air emissions -- for extended periods of time (10).

REGULATORY CONSIDERATIONS

Automatic waste feed shutoffs, continuous emissions monitors, and destruction and removal efficiencies are set by regulatory authorities depending on the type of wastes being incinerated and the regulatory authority of the involved state. If the incinerator burns hazardous waste, it is regulated as a hazardous waste incinerator subject to federal or state hazardous waste regulations. Federal hazardous waste regulations pertaining to incineration are administered under the Resource Conservation and Recovery Act of 1976 as amended (RCRA), 42 U.S.C. 9621(e)(1), which is the major legislation that applies to all facets of generation, transportation, treatment, storage, and disposal of hazardous wastes in the United States. Some states, which have passed hazardous waste regulations at least as restrictive as those specified under RCRA, may be authorized by EPA to administer their own regulations. In such cases, a state's requirements may exceed those imposed under RCRA.

If, as in most cases involving mobile incinerators, the hazardous waste incinerator is used as a remedy for an on-site cleanup of a Superfund site, "no Federal, state, or local permit shall be required." That provision is made in the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (P.L. 96-510), as amended by the Superfund Amendments and Reauthorization Act of 1986 (P.L. 99-499). However, the CERCLA incinerator must comply with all the technical requirements that would be applied to a permitted hazardous waste incinerator. In other words, all technical requirements of a RCRA-regulated incinerator would apply to a Superfund remediation incinerator, except that a specific permit would not be issued for the Superfund incinerator. That provision was made to expedite remediation of this nation's Superfund sites by eliminating the very long period, sometimes several years, required to obtain permits for hazardous waste treatment. The Superfund program is still obligated to ensure that relevant provisions of the applicable laws or statutes are being met. **This approach, as applied to CERCLA waste incinerators, is important to help ensure that certain regulatory provisions protective of public health are addressed even when the incinerator is not a RCRA-permitted facility.**

OTHER CONSIDERATIONS OF IMPORTANCE TO PUBLIC HEALTH

Training of Operators

Even with all the proper design features, skilled operators are essential for a safe, effective incineration program. Operators should understand the principles of good combustion and be

thoroughly familiar with all major and support systems at their plants. Careful attention to proper waste burn rates and waste blending, as needed, helps to ensure that the combustion systems are not overloaded and that the AWFSOs are not activated excessively. Routine maintenance, inspection, and instrument calibrations should be conducted and recorded. Safety and emergency response plans that thoroughly address likely failure scenarios (including power, systems, and operational failures) must be in place, documented, and shared with local officials. Emergency "release" drills should be conducted periodically with the knowledge and involvement of local emergency response personnel. In addition, all employees should be adequately trained in appropriate health and safety procedures for the safe day-to-day operation of the incinerator.

Siting of the Incinerator

Another consideration relevant to public health and frequently raised by the public is the location of the incinerator with respect to the community. More specifically, what are the possible health impacts associated with living or working in the path of incinerator emissions? To address those concerns, when reviewing the location of an incinerator, regulatory agencies use generally accepted air dispersion models in conjunction with local meteorologic data to determine the permit conditions necessary to protect human health and the environment. Such modelling results can be particularly helpful in identifying prevailing wind transport patterns and their effect on downwind pollutant concentrations. Ideally, the site should not be where modeled high ground-level concentrations of stack emissions coincide with population centers. Dispersion models can also help evaluate the need for, and the location of, off-site air monitors used to detect fugitive emissions associated with incinerator operations and related hazardous materials-handling activities. If there is concern about the impact of incineration on a specific major food resource, such as a fish hatchery, and ATSDR has data regarding the uptake of the contaminants of concern by the particular food chain species, dispersion modelling can serve to estimate the concentration of emissions that would be available at ground level for food chain uptake. Finally, it should be noted that there is little flexibility in selecting a site for a Superfund incinerator, except with regard to where it is placed within the boundaries of the actual site. However, modelling as mentioned here is still useful in reviewing whether or not to use incineration for cleanup of a particular site.

Storage of Materials

In addition to the aforementioned issues regarding the

incineration process, **other concerns of relevance to public health need to be addressed.** For example, hazardous waste to be fed to the incinerator and process effluents resulting from the incinerator should be stored in a manner that does not allow for uncontrolled environmental releases of potentially harmful substances. Dry, dusty materials should be enclosed or otherwise stored to prevent windborne transport of contaminated particulates. Wastes containing volatile organic compounds should be stored under conditions that safely collect and remove gases released from the wastes.

Similarly, wet wastes or process effluents should be stored in chemically compatible, leak-resistant containers. Storage areas for such liquid-bearing materials should have dikes or be designed to contain leakage. Processing of wastes, such as blending or shredding operations, may provide opportunities for aerosolization of contaminants. Such conditions should be adequately considered and waste-processing areas designed to minimize the potential exposure to workers on-site, as well as to people living or working nearby.

Transportation of Wastes to the Incinerator

Finally, the means of transporting hazardous waste into the incinerator plant should be carefully considered. Routes of access should be selected to minimize accident (release) potential and to avoid residential and play areas if possible. For the remediation of Superfund sites, for which no over-the-road hauling is required, care is still needed to avoid spills and releases when transporting the wastes on site.

Maintaining Good Performance

Some considerations relevant to public health concerns about modern and effective incineration systems have been described. However, local health officials and citizens of communities with hazardous waste incinerators have expressed to ATSDR their concern that they may not be able to judge a good operation, or that, once the initial trial burns and inspections are completed, the system may not be operated in the same manner as during the testing phase. Citizens also have expressed concerns that burning rates will be exceeded or monitoring systems will be overridden. What can be done to guard against such conditions?

ATSDR believes one way to ensure that the system continues to operate in a manner consistent with operating conditions specified in the CERCLA contract, is for EPA to conduct frequent, random, unannounced facility inspections and to routinely provide the results to the public. Under some circumstances, permanent on-site inspectors might be advisable.

Another way to ensure continued satisfactory operation is to retest the incinerator periodically. This would be appropriate if the CERCLA incinerator operates at the site for an extended period of time, or there are other indications that it may not be operating properly.

Each time a CERCLA incinerator is relocated, ATSDR recommends that it be retested. A less rigorous trial burn may be appropriate if the incinerator successfully passed a full trial burn on similar wastes at another site.

Community Right-to-Know

ATSDR also strongly recommends that information and data concerning an incinerator's design, testing, operation, and monitoring be shared with the public. The Agency endorses that approach as being consistent with the community right-to-know requirements already in place for industries that use and store hazardous substances in the community.

SUMMARY OF PUBLIC HEALTH CONSIDERATIONS

Public health assessors should be aware of the generally recognized good practices listed in Table 1 when examining the public health acceptability of a proposed or existing hazardous waste incinerator. Most of the considerations described in Table 1 are already a part of the EPA RCRA and CERCLA oversight process.

As reliance on incineration as a remediation technology increases, ATSDR will collaborate with EPA in a number of areas to further broaden the data-base used in regulatory decision-making and in evaluation of health implications associated with incinerator technology. Public health assessors are advised to contact the Division of Health Assessment and Consultation to get more information.

With careful attention to design and proper operation of the facility, significant quantities of hazardous waste can be reduced to smaller volumes of material that can be managed safely. With the vigilance of the regulatory community and the involved citizenry, the facility can operate as specified in the CERCLA operation and maintenance plan.

It is hoped that this overview provides public health assessment professionals with a general understanding of the key considerations and concerns related to hazardous waste incineration technology. As noted throughout this document, EPA plays a leading role in selecting or permitting, implementing, testing, and overseeing such technology. Most of the

documentation needed by the public health assessor to evaluate a specific incinerator can be obtained from EPA. Table 2 contains a list of typical site-specific documents of interest to the public health assessor. In addition, Table 3 lists EPA guidance and resource documents that will be of assistance to the public health assessor. As a final caution, it must be remembered that each site is unique, and must be carefully evaluated individually and not by generic extrapolation of data from other sites or studies.

TABLE 1. SUMMARY OF PUBLIC HEALTH CONSIDERATIONS

The following items should be considered when evaluating CERCLA incinerators:

- the technology used or proposed to be used at a site is proven to be appropriate for, and compatible with, the materials to be burned;
- in selecting a site for a CERCLA incinerator, proximity to residential and other populations and local meteorologic conditions is considered to ensure a location that minimizes prevailing wind transport of air emissions to affected populations;
- recognized, acceptable, and when possible, EPA-approved air modeling is used to help screen and identify potentially impacted areas as mentioned previously;
- trial burns, with appropriate stack sampling and analysis, and subsequent continuous emissions monitoring are conducted to demonstrate that the incinerator performs as specified;
- adequate training is provided to incinerator operators to ensure that the incinerator is operated in a manner that does not adversely affect the operators' or the community's health;
- an active inspection program is instituted,
- where the incinerator must be at a site close to neighboring populations, local ambient air monitors are used to detect possible site releases to the air requiring corrective or emergency action,
- proper management of residual ash is part of the design and operation of the incinerator; and,
- procedures consistent with the community right-to-know philosophy are instituted.

TABLE 2. PERTINENT DOCUMENTS FOR PUBLIC HEALTH ASSESSOR REVIEW

DOCUMENT*	RELEVANCE TO PUBLIC HEALTH ASSESSMENT
1. Trial Burn Plan and Trial Burn Report	• provides data on the typical and/or worst case emissions under specific operating conditions, for use in air pathway analysis
2. QA/QC Plan and Sampling Plan	• permits review of data collected to see that they are of adequate quality to assess the health impact on the community
3. Remedial Design Plan or Engineering/Design Plan	• permits review of containment and material flow provisions to assess the potential for releases to air, water and soil pathways; also permits review of process monitoring and safeguards against process upsets
4. Site Health & Safety Plan Contingency Plan	• describes how emergency releases of contaminants are monitored and how the community is safeguarded
5. Operation & Maintenance Plan and Inspection Schedules	• specifies the routine checks of equipment, waste storage areas, etc., and calibration of monitoring equipment to minimize opportunity for process upset or unplanned hazardous material releases; useful in assessing the potential for releases.

* Names of the documents described here may vary.

TABLE 3. EPA HAZARDOUS WASTE INCINERATION DOCUMENTS

Hazardous Waste Incineration Guidance Series:

Volume I:	Guidance Manual for Hazardous Waste Incinerator Permits, July 1983.
Volume II:	Guidance on Setting Permit Conditions and Reporting Trial Burn Results, January 1989.
Volume III:	Hazardous Waste Incineration Measurement Guidance Manual, June 1989.
Volume IV:	Guidance on Metals and Hydrogen Chloride Controls for Hazardous Waste Incinerators, August 1989.
Volume V:	Guidance on PIC Controls for Hazardous Waste Incinerators, April 1989.
Volume VI:	Proposed Methods for Measurement of CO, O_2, THC, HCL, and Metals at Hazardous Waste Incinerators.

Other Useful EPA Resource Documents:

Quality Assurance/Quality Control (QA/QC) Procedures for Hazardous Waste Incineration.

Engineering Handbook for Hazardous Waste Incineration. September 1981.

Trial Burn Observation Guide. 1988.

:NCES

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