8.0   INCINERATION

Thermal treatment processes include those designed to destroy the contaminants, such as incineration, and those designed to effect transfer of the contaminants to the gas phase, such as thermal desorption (see Section 4). Incineration is seldom used to remediate soils contaminated with fuel products because of economic considerations, and it is much less commonly employed for this purpose than thermal desorption, excavation and removal, and other treatment technologies.

8.1   Process Description

A broad range of technologies can be categorized as thermal destruction/ incineration. The most common incineration technologies include liquid injection, rotary kiln, and multiple hearth (Lee, et al., 1986; Cheremisinoff, 1986). However, for remediation of fuel-contaminated soils, rotary kilns are most often used. In general, soil remediation by thermal destruction can be classified under two general categories: 1) on-site treatment using a transportable incinerator, or 2) shipment of contaminated soils off-site to a larger, permanent incinerator. For the treatment of soils contaminated with petroleum fuels, on-site incineration using mobile or transportable units is much more common than off-site incineration. Although incineration is a well-established technology, the evolution of mobile or transportable incinerators is a more recent development.

The literature on incineration is very extensive. The best source of information on air emissions from incineration is a recent review (Dempsey and Oppelt, 1993), which is contained in Appendix G to this report.

In broad terms, thermal destruction of hazardous waste is an engineered process in which controlled combustion is used to reduce the volume of an organic waste material and render it environmentally safe. Thermal treatment is a flexible process capable of being used for many waste types including solids, gases, liquids, and sludges.

Figure 8-1 shows a generalized process flow diagram for incineration systems. A typical system includes the waste feed system, primary and (in most cases) secondary combustion chambers, and exhaust gas conditioning system.

At the front-end of a hazardous waste incineration system is the waste feed process. The configuration of the waste feed system is determined by the physical characteristics of the waste. Contaminated soil is introduced to the combustion chamber by means of screw augers or belt feeders. If liquids are to be treated as well in the incinerator, they are usually injected into the unit by means of an atomization nozzle(s), which uses steam or compressed air as an atomization fluid. Liquids with entrained solids may require screening to prevent clogging of the atomizer nozzle.

The largest part of the waste destruction usually takes place in the primary combustion chamber. As mentioned earlier, for contaminated soils this chamber is usually a rotating kiln. Gases formed in the primary combustion chamber are then routed to a secondary combustion chamber, or afterburner, where any unburned hydrocarbons or products of incomplete combustion such as CO can be

Figure 8-1. Process Flow Diagram for Commercial Rotary Kiln Incinerator.

fully oxidized. Temperatures typically will be 1200-2300°F in the primary chamber and 2000-2500°F in the after burner.

After the combustion gases leave the incinerator, they may be routed through a variety of air pollution control devices including gas conditioning, particulate removal, and acid gas removal units. Gas conditioning is accomplished with equipment such as waste heat boilers or quench units. Typical particulate removal devices include venturi scrubbers, wet electrostatic precipitators, ionizing wet scrubbers, and fabric filters. Acid gas removal units include packed-, spray-, or tray-tower absorbers; ionizing wet scrubbers; and wet electrostatic precipitators.

The advantages of thermal treatment include the following:

- Demonstrated effectiveness;

- Applicability to a wide range of wastes (can be used on most contaminant and soil types); and

- High commercial availability.

However, thermal treatment also has a number of significant disadvantages such as:

- High cost;

- Public resistance to the construction and permitting of incinerators; and

- The need to meet stringent treatment requirements for process residuals.

8.2   Identification of Air Emission Points

The air emissions associated with full-scale thermal treatment are primarily stack emissions of combustion gas. There may, however, be some additional evaporative emissions from equipment leaks and waste handling. Full-scale, off-site incineration units may vent all emissions from waste handling and transfer activities to the combustion chamber as make-up air. The air emissions for on-site incinerators are similar to off-site units, except that waste handling activities have a greater likelihood of being uncontrolled. For off-site units, typical incinerator stacks will be 100-200 ft high. For transportable units, stack heights range from 40-100 ft. The fugitive emissions sources associated with thermal treatment will likely be ground-level.

As previously discussed, fugitive emissions from excavation and other area sources may be a significant fraction of the total air emissions.

8.3   Typical Air Emission Species of Concern

Emissions from both on-site and off-site incinerators include: undestroyed organics, metals, particulate matter, NO_x, CO, and acid gases. The cause of each of these pollutants is discussed below. Fugitive emissions associated with excavation, storage, and handling of the feed material must also be considered when assessing potential air impacts from incineration (see Section 3).

8.3.1   Unburned Hydrocarbons

In general, incinerators treating wastes must achieve a required destruction

and removal efficiency of at least 99.99% for RCRA wastes and 99.9999% for PCB- or dioxin surrogate wastes. The remaining 0.01% or 0.0001% of the waste can be assumed to pass through the system uncombusted (Eklund, et al., 1989). However, in addition to unburned hydrocarbons there may be some additional reactions in the combustion process that may produce a number of other organic compounds, called products of incomplete combustion (PICs). PICs may include dioxins, formaldehyde, and benzo(a)-pyrene and other PAHs. PIC formation is not restricted to the combustion chamber; the reactions which produce PICs may continue to occur in the combustion gases as they travel through the incineration system and out of the exhaust system (Eklund, et al., 1989; Treholm and Oberacker, 1985).

Studies indicate that PIC emissions are a natural consequence of the kinetically-limited thermal degradation of hazardous wastes. Comparison of PIC formation/destruction rates based on theory and nominal incineration conditions indicate that PIC emissions can be several orders of magnitude higher than predicted based on equilibrium (Dellinger, et al., 1991). This finding suggests that temporal or spatial excursions from these nominal conditions are occurring, which lead to PIC formation. Possible causes of PIC emissions include low temperatures due to quenching, residence-time short circuits due to nonplug flow and/or unswept recesses, and locally high waste/oxygen concentration ratios due to poor microscale mixing.

Dioxins and furans are potential PICs. Dioxins are three-ringed compounds of the chemical family dibenzo-p-dioxins. Furans are three-ringed structures of the chemical family dibenzofurans that are similar in structure to dioxins. "Dioxin" and "furan" usually refer to the chlorinated congeners of dibenzo-p-dioxin and dibenzofuran. Dioxins and furans are considered to be potent carcinogens. These compounds may be present in incinerator exhaust gas as a result of incomplete combustion or the recombination of exhaust products from the burning of mixtures containing chlorinated compounds (Dempsey and Oppelt, 1993). The total dioxin/furan emissions tend to correlate with the chlorine content of the waste feed (Helble and Hlustick, 1994). Thus, dioxin and furan emissions should not be a concern for the treatment of soils containing petroleum fuels with no chlorinated compounds present.

8.3.2   Metals

The metals introduced to the incinerator via the waste feed stream are not destroyed. Depending on their boiling point, they can either be volatilized or remain as solids. Volatilized metals will exit the stack as a gas or they will condense or adsorb onto particles in the stack gas stream. Metals associated with particulate matter (PM) will be captured in the PM control device. Non-volatilized metals can be fluidized and swept up into the combustion gas or leave the incinerator in the bottom ash.

8.3.3   Particulate Matter

The waste feed, auxiliary fuel, and combustion air can all serve as sources for particulate emissions from an incineration system. Particulate emissions may result from inorganic salts and metals that either pass through the system as solids or vaporize in the combustion chamber and recondense as solid particles in the stack gas. High-molecular-weight hydrocarbons may also

contribute to particulate emissions if oxidation is not complete. RCRA requirements for particulate emissions call for a limit of 0.08 grains/dscf corrected to 7% O_2. A number of potential PM control devices can be used, including venturis, wet electrostatic precipitation, ionizing wet scrubbers, and fabric filters.

8.3.4 Nitrogen Oxides

Achieving high levels of destruction of organic wastes is directly related to combustion chamber temperature: the higher the temperature, the greater the destruction and removal efficiency (DRE) of organics. Unfortunately, the fixation of nitrogen and oxygen to form NO_x also increases with combustion temperatures. NO_x emissions caused by this mechanism are referred to as thermal NO_x. Also, if there are bound nitrogen atoms in the waste (e.g. amines), additional NO_x emissions, called fuel NO_x, will be formed. In such cases, two-stage combustion or emissions controls may be needed.

8.3.5 Carbon Monoxide

Carbon monoxide emissions are generally low (<100 ppmv) in incinerators because of the high operating temperatures and excess oxygen maintained in the process.

8.3.6 Acid Gases

Hazardous waste incineration will also produce acid gases. These include oxides of sulfur (SO_x) and halogen acids (HCl, HF, and HBr). The sulfur, chlorine, fluorine, and bromine contents of the waste and fuel feed determine the emission levels of their respective acid gases. The concentrations of these elements range widely amongst different wastes; consequently, the resulting acid gas emissions will also show wide variability. Acid gas emissions are usually not a concern for the incineration of soils contaminated by petroleum fuels. Most incinerators are equipped with some type of flue gas treatment system to control acid gas emissions. Control efficiencies typically range from 85-99%. Units treating soil contaminated with halogenated solvents generally are required to meet RCRA requirements governing HCl emissions.

8.4 Summary of Air Emissions Data

The wide variety in design and operation of incinerators makes it difficult to generalize about air emissions. However, extensive research has been done to determine the range of unburned hydrocarbon and PIC emissions that can be expected from full-scale incinerators. Table 8-1 shows the range of PIC concentrations found in testing of several different full-scale incinerators. Given the volume flowrate of the incinerator off-gas, these concentrations can be used to estimate the range of emissions from a particular incinerator system. The data in Table 8-1 are not necessarily based on the incineration of fuel- contaminated soils, and therefore, may overestimate emissions from the treatment of fuel-contaminated soils.

A summary of dioxin and furan emissions from incinerators and other thermal destruction facilities is given in Table 8-2. Emissions of dioxins and furans

Table 8-1
PICs Found in Stack Effluents of Full-Scale Incinerators[1]

PIC	Number of Sites	Concentrations (ng/L)
Benzene	6	12 - 670
Chloroform	5	1 - 1,330
Bromodichloromethane	4	3 - 32
Dibromochloromethane	4	1 - 12
Bromoform	3	0.2 - 24
Naphthalene	3	5 - 100
Chlorobenzene	3	1 - 10
Tetrachloroethylene	3	0.1 - 2.5
1,1,1-Trichloroethane	3	0.1 - 1.5
Hexachlorobenzene	2	0.5 - 7
Methylene chloride	2	2 - 27
o-Nitrophenol	2	25 - 50
Phenol	2	4 - 22
Toluene	2	2 - 75
Bromochloromethane	1	14
Carbon disulfide	1	32
Methylene bromide	1	18
2,4,6-Trichlorophenol	1	110
Bromomethane	1	1
Chloromethane	1	3
Pyrene	1	1
Fluoranthene	1	1
Dichlorobenzene	1	2 - 4
Trichlorobenzene	1	7
Methyl ethyl ketone	1	3
Diethyl phthalate	1	7
o-Chlorophenol	1	2 - 22
Pentachlorophenol	1	6
2,4-Dimethyl phenol	1	1 - 21

[1]Data from Trenholm, Gorman, and Jungclaus, 1984.

Table 8-2
Dioxin/Furan Emissions from Thermal Destruction Facilities
(ng/dscm @ 7% O_2)

Facility Type[a]	Sample (Waste)[b]	2378-TCDD	PCDD	PCDF	I-TEQs/89[c] ng/dscm	I-TEQs/89[c] g/yr[d]
HWI (Commercial, Rotary Kiln, Liquid Injection)	FG[e] (HW)	ND[f]	ND	ND	ND	ND
HWI (Confidential)	FG/FA (HW)	ND	22	70	17.7	1.95
HWI (On-site Liquid Injection)	FG (HW)	ND	ND	7.3	0.93	0.02
HWI (On-Site Liquid Injection)	FG (HW)	ND	ND	ND	ND	ND
HWI (Commerical, Two Chamber, Liquid Injection and Hearth)	FG/FA (HW)	ND	ND	1.7	0.57	0.02
HWI (On-site Kiln and Liquid Injection in Parallel)	FG (HW)	ND	ND	ND	ND	ND
HWI (Liquid Injection Incinerator Ship)	FG/FA (PCB)	ND	ND	ND	0.3	0.16
HWI (Fixed Hearth)	FG/FA (PCP)	ND	ND	ND	ND	ND
HWI (Liquid Injection)	FG/FA (PCB)	ND	0.64	9.9	1.63	0.81
HWI (Rotary Kiln/Liquid Injection)	FG/FA (PCB)	0.003	0.108	3.18	0.073	0.001
HWI (Pilot-scale Rotary Kiln)	FG/FA (PCB)	0.003	0.108	3.18	.073	0.001
Cement Kiln	FG (HW)	ND	ND	ND	ND	ND
Cement Kiln	FG (HW	ND	ND	ND	ND	ND
Lime Kiln	FG/FA (HW)	ND	ND	ND	ND	ND
Industrial Boiler/A (Watertube Stoker)	FG/FA (PCP)	ND	75.5	NR[g]	10.5	0.84
Industrial Boiler/D (Converted Stoker)	FG/FA (HW)	ND-0.002	0.64-0.8	0.24-5.5	0.45	0.12
Industrial Boiler/E (Packaged Watertube)	FG/FA (HW)	ND	ND	0.14	0.01	0.0026

Table 8-2
(Continued)

Facility Type[a]	Sample (Waste)[b]	2378-TCDD	PCDD	PCDF	I-TEQs/89[c] ng/dscm	g/yr[d]
Industrial Boiler/M (Tangentially Fired Watertube)	FG/FA (HW)	ND	ND	0.81	0.11	NA[h]
Industrial Boiler/L (Packaged Watertube)	FG/FA (HW)	ND	1.1	2.5	0.336	NA

[a]HWI = Hazardous Waste Incinerator.

[b]Information in parentheses describes waste feed; HW = hazardous waste; PCB = polychlorinated biphenyls; PCP = pentachlorophenol waste.

[c]Calculated by the International Toxicity Equivalency Factor/89 (I-TEF/89) method. If isomer specific data were not available, homologue data were considered to be composed of the most toxic isomers.

[d]Assumes 8160 operating hours per year.

[e]FG = flue gases analyzed; FA = flue gas particulate analyzed.

[f]ND = not detected.

[g]NR = not reported.

[h]NA = Not available.

[i]SDA/FF = spray dryer absorber/fabric filter.

[j]ESP = electrostatic precipitator.

Source: Dempsey and Oppelt, 1993.

from hazardous waste incinerators generally are below detection limits. Reasonable worst-case emission rates of polychlorinated dibenzo-p-dioxin (PCDD) and tetrachlorodibenzofuran (TCDF) are 102 and 1.41 ng/m^3, respectively (Dempsey and Oppelt, 1993). Results of recent dioxin/furan emissions tests are summarized in Table 8-3.

8.5   Identification of Applicable Control Technologies

Unlike other soil remediation technologies, incineration does not require additional add-on VOC controls because it converts organics into carbon dioxide and water. However, additional controls are usually required to reduce emissions of acid gases, particulate matter (PM), and metals.

The two primary alternatives for controlling acid gas and PM emissions are wet or dry scrubbing systems. Wet scrubbing systems typically use a packed- or spray-tower scrubber with a caustic scrubbing solution to remove acid gases and a venturi scrubber or wet electrostatic precipitator to remove particulate matter. Dry scrubbing systems typically use a spray dryer absorber or dry sorbent injection to remove acid gases from the waste gas stream. The calcium-based alkali absorbent is usually in the form of slaked lime. Semi-dry systems inject the alkali as a slurry with water which is then evaporated. Dry ESPs or fabric filters are used to remove particulate matter from the gas stream. Table 8-4 shows typical ranges of emissions and estimated removal efficiencies for acid gas and PM control systems. The efficiency of PM control systems depends on the particle-size range present in the flue gas.

Pollutants of special concern from incinerators include mercury and dioxins/furans. Recent tests by the EPA have demonstrated mercury control efficiencies averaging 87% using a wet scrubber (Carroll, Thurnau, and Fournier, 1995). Dioxins/furans typically are present in the vapor-phase (70-80% of the total), so particulate matter controls are of limited effectiveness for these compounds (Williamson, 1994). Emissions of dioxins and furans can be controlled through the use of activated carbon. Dioxin and furan emissions have been reduced to <0.1 ng/m^3 using an activated carbon filter (Steinhaus and Dirks, 1994) and have been reduced over 90% using process control and carbon injection (Sigg, 1994).

8.6   Costs for Remediation

The costs to use thermal destruction to remediate fuel-contaminated soil will vary from site to site and depend on whether on-site or off-site treatment is used. The choice between off-site and on-site incineration is usually determined by the volume of soil to be treated and the proximity of full-scale off-site hazardous waste incinerators. The cost of using a transportable on-site incinerator will only be justified if the volume of contaminated soil to be remediated is large and/or the expense of off-site incineration is excessive because of transportation costs or other factors.

Table 8-5 shows approximate costs for off-site incineration. As the table shows, the estimated cost for incinerating contaminated soil is $540 - $1,070 per ton including transportation costs. It should be emphasized that this costs will vary with type of contamination and the volume of soil to be remediated (Cochran, et al., 1987).

Table 8-3
Recent Dioxin/Furan Emissions Data

Trial	Total Dioxins ng/dscm	Total Furans ng/dscm	TEQ ng/dscm	Reference
Plant A	4.34-7.12	1.48-2.86	0.06-0.133	Santoleri, 1994
Plant B	3.43	66.63	0.054	
Plant C[a]	0.403-0.76	1.95-4.35	4.83-5.72	
Plant D	2.71-23.25	4.23-12.57	0.126-0.415	
EPA Research Facility	0.081-0.130	2.53-4.42	--	Waterland and Venkatesh, 1994
Trial Burn		3.6-210[b]	0.056-2.45	Canter, 1995
Performance Tests		0.7-39[b]	0.010-0.27	

[a]Level of chlorinated organics in waste feed was 22%.
[b]Dioxins + furans.

Table 8-4
Characteristics of Off-Gas from On-Site Incineration Systems

Table 8-4a. Typical Properties of Off-Gas from Combustion Chamber[a]

Parameter	Units	Value
Air flow rate	ACFM	30,000 - 50,000
Temperature of Exit Gas	°C (°F)	760 - 982 (1,400 - 1,800)
Oxygen Content	%	3
System Pressure Drop	In. H_2O	10 - 15

[a]Based on a limited number of designs.

Table 8-4b. Typical Emissions

	EPA[b] Conservative Estimated Efficiencies	Typical Actual Control Efficiencies	Typical Range of Emission Rates
Particulate Matter	99+%	99.9+%	0.005-0.02 gr/dscf
Hydrogen chloride (HCl)	--	99+	10-50 mg/Nm^3
Sulfur dioxide (SO_2)	--	95+	30-60 mg/Nm^3
Sulfuric acid (H_2SO_4)	--	99+	2.6 mg/Nm^3
Arsenic	95	99.9+	1-5 µg/Nm^3
Beryllium	99	99.9	<0.01-0.1 mg/Nm^3
Cadmium	95	99.7	0.1-5 mg/Nm^3
Chromium	99	99.5	2-10 mg/Nm^3
Antimony	95	99.5	20-50 mg/Nm^3
Barium	99	99.9	10-25 mg/Nm^3
Lead	95	99.8	10-100 mg/Nm^3
Mercury	85 - 90	40 - 90+	10-200 mg/Nm^3
Silver	99	99.9+	1-10 mg/Nm^3
Thallium	95	99+	10-100 mg/Nm^3
PCDD/PCDF[c]	--	90-99+	1-5 ng/Nm^3

[b] Based on spray dryer fabric filter system or 4-field electrostatic precipitator followed by a wet scrubber.
[c] Total of all congeners.

SOURCE: Donnelly, 1991.

Table 8-5
Estimated Range of Costs for Off-Site Incineration[a]

Types of Waste	Cost Range, $/Mg ($/ton)
Drummed Waste	154 - 490 (170 - 540)
Liquids	64 - 490 (70 - 540)
Clean Liquids with High Btu Value	18 - 64 (20 - 70)
Soils and/or Highly Toxic Liquids	490 - 971 (540 - 1,070)

[a]Data from Cochran, R., et al., 1987.

Table 8-6
Estimated Range of Costs for On-Site Incineration[a]

Site Size (Tons)	Cost Range, $/Mg ($/ton)
Very Small (<5,000)	481 - 1,433 (530 - 1,580)
Small (5,000 - 15,000)	354 - 925 (390 - 1,020)
Medium (15,000 - 30,000)	236 - 617 (260 - 680)
Large (>30,000)	163 - 481 (180 - 530)

[a]Data from Engineering Bulletin: Mobile/Transportable Incineration Treatment (U.S. EPA/540/2-90-014) 1990. Data are for the treatment of hazardous waste.

Table 8-6 shows approximate costs for on-site incineration (U.S. EPA 1990). As indicated in the table, costs may range from $180 to $1,580 per ton depending on the volume of soil being remediated. Also, as the table shows, on-site incineration is most economical when a large volume of waste must be treated. The cost of remediation per ton falls significantly as the volume increases. For large-scale on-site incineration, capital costs are on the order of $5,000,000—$15,000,000. Operating costs, which consist primarily of fuel and labor, will also be substantial. Additional costs will also be incurred for the disposal of the incinerator ash, unless the treated soil can be backfilled on-site.

8.7   Costs for Emissions Controls

Costs for controlling acid gas and particulate emissions are substantial. Depending on the volume of gas treated, the installed cost for a wet scrubbing system on a full-scale (i.e., fixed base) incinerator could be $1,000,000-$3,000,000. Costs for wet scrubber controls for a mobile system are likely to be on the order of $200,000-$1,000,000. Similar costs would be expected for dry scrubbing systems.

8.8 Equations and Models for Estimating VOC Emissions

A simple mass approach (Thompson, et al., 1991) can be used to estimate emissions from incineration. Separate correlations for each pollutant of concern are presented below.

8.8.1 Unburned Hydrocarbons

An emission rate for unburned hydrocarbons can be generated from a mass balance on the incinerator system:

$$ER_i = [1-(DRE_i/100)](C_i)(m_w)$$

where:

$ER_i =$ emission rate for pollutant i (g/hr);

$DRE_i =$ destruction efficiency (assume 99.99% if not known);

$m_w =$ total mass flow rate of waste feed (kg/hr); and

$C_i =$ waste feed concentration for pollutant i (g/kg).

Typical feed rates for soils are 5,900 kg/hr, with a range from 900 to 24,000 kg/hr (Eklund and Albert, 1993).

8.8.2 Products of Incomplete Combustion

Emissions of PICs, both the amount and the type, will vary greatly from unit to unit depending on design and waste feed. Data is currently unavailable to generate a single emission factor.

8.8.3 Metals

Metals are not destroyed in the incineration process. They leave the system via either the bottom ash, are captured in the air pollution control system, or exit with the stack gas. There are currently no correlations available for determining the partitioning of metal emissions in incineration systems. If stack data is available for the incinerator in question, metals emissions rates can be estimated from:

$$ER_i = (C_i)(m_w)(\%ME_i/100)$$

where:

$ER_i =$ emission rate for metal i (g/hr);

$C_i =$ concentration of metal i in the feed (g/kg);

$m_w =$ mass flow rate of waste (kg/hr); and

$ME_i =$ metal emitted to air expressed as a percentage of metal fed (%) (See Dempsey and Oppelt, 1993 - Appendix G, Table XV).

8.8.4 Acid Gases

The production of acid gases (HCl, SO_2, and HF) is determined by the respective chlorine, sulfur, and fluorine contents in the waste and fuel feed streams. A conservative approach to calculating the air emissions of these acid gases is to assume complete conversion of Cl, S, and F into their respective acid gas products and apply a typical removal efficiency for the air pollution control system. These equations follow the form:

$$ER_i = (Cj)(R_{i/j})m_w(1-\%CE_i/100)$$

where:

ER_i = emission rate for acid gas i (g/hr);

C_j = concentration of element (Cl, S, or F) in waste (g/kg);

$R_{i/j}$ = stoichiometric ratio of acid gas to (g/g);

m_w = mass flow rate of waste (kg/hr); and

CE_i = control efficiency of acid gas treatment system (%).

8.8.5 Nitrogen Oxides and Carbon Monoxide

In general, incinerator systems are not considered significant sources of NO_x emissions. NO_x is usually only a concern for wastes with high nitrogen content. Typical NO_x emissions for an incinerator may be on the order of 100-200 ppmv (dry basis), or expressed on a fuel basis, 0.12-0.33 lbs NO_x per MMBtu. If a low-NO_x burner is used, the emissions may be on the order of 0.05 lbs of NO_x per MMBtu.

CO emissions from incinerators are also not considered a major problem. Most systems are designed to be fired with excess air (i.e., oxygen rich) to ensure complete combustion of organic material to carbon dioxide. Vendors typically guarantee CO emissions less than 100 ppmv (dry basis). Actual measured CO levels are often lower.

8.9 Case Study: On-Site Incineration

No suitable case study was found for the incineration of soils contaminated with petroleum fuels.

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