Incineration of Radioactive and Mixed Waste

Incinerators burn waste at high temperatures. The main purpose of incinerating radioactive waste is to reduce waste volume, since a large proportion consists of bulky items such as contaminated clothes, lumber, and plastic. Incineration of waste that is a mixture of chemically hazardous and radioactive materials, known as "mixed waste," has two principal goals: to reduce the volume and the total chemical toxicity of the waste.

Health and Environmental Risks

Incineration does not destroy metals or reduce radioactivity of wastes. Radioactive waste incinerators, when equipped with well-maintained, high efficiency filters, can capture all but a small fraction of the radioactive isotopes and metals fed into them. The fraction that does escape, however, tends to be in the form of small particles that are more readily absorbed by living organisms than larger particles.

Incinerators, like many combustion devices such as automobile engines, convert combustible materials mainly to carbon dioxide and water (steam). But they generally also create toxic by-products, known as "products of incomplete combustion" or (PICs). PICs can be more toxic per unit weight than the original wastes. The total quantity and toxicity of PICs from incinerators is highly uncertain. [1] The most widely-studied toxic PICs are known as dioxins.

Dioxins and similar toxic chemical compounds accumulate in fatty tissue, increasing in concentration at each successive level of the food chain. Until 1993, regulations did not factor in food chain exposure.

Although special filters can reduce toxic emissions to well below legal limits, they also concentrate toxins in ash. Landfilled ash and contaminated filters present greater threats to groundwater than the original wastes in some cases. [2] Permanent storage of ash in well-monitored structures can minimize the risk of groundwater contamination.

Incinerator Regulations

The federal government has set limits on radioactive releases from all incinerators burning radioactive waste (noted next page). For mixed waste incinerators, the federal Environmental Protection Agency (EPA) also set limits on a variety of other pollutants based on the estimated health risks. [3] The "excess" cancer-risk standards–the risks to a person exposed for 70 years from an individual mixed waste incinerator releasing its legal limit of specific air pollutants—are as follows:

- a 1 in 1800 to 1 in 3600 chance of fatal cancer from exposure to emissions of radioactivity (estimated using the radiation dose limit set by the federal government) [4]
- a l in 100,000 chance of contracting cancer from combined exposure to emissions of arsenic, beryllium, cadmium, chromium, as well as dioxins and furans (compounds similar to dioxins)

Some states have set more stringent limits. In addition, actual risks may be considerably lower for some of these hazards. For example, the Department of Energy (DOE) estimates that in 1991 its mixed waste incinerator near Oak Ridge, Tennessee emitted less than 3 percent of its legal limit for releases of

radioactive materials. This translates into a risk of less than 1 in 60,000 to less than 1 in 120,000.

However, cancer may not be the primary hazard from some pollutants like dioxins; other effects such as disruption of the immune or reproductive systems may be more important. [5] US standards for dioxins and furans are typically much weaker than European standards. [6]

The federal regulations for some emissions from mixed waste incinerators are designed to prevent both acute and chronic health effects, even if exposure occurs for a lifetime. Some other potentially toxic emissions are unregulated (for example, selenium and nickel). [7]

The range of uncertainty in risk estimates is great due to:

- difficulty establishing low-dose biological effects
- assumptions about exposure (such as location and health of the exposed individual)
- lack of knowledge about non-cancer effects and effects of combinations of pollutants

Incinerators burning radioactive waste (as opposed to mixed waste) are not subject to federal limits on most toxic chemical emissions–including metals other than lead. Even lead may not be regulated in a polluted area, unless the incinerator is considered a significant source of regional pollution. [8]

Incinerator regulations often fail to address the acceptability of risks to the people subjected to those risks; in other words, whether the risks are voluntarily or involuntarily imposed. Regulations generally also fail to account for impacts on plants and animals unless they are associated with human health impacts.

US Department of Energy Existing and Proposed Incinerators [9]

FACILITY NAME [10] / PLACE [11]	TYPE [12]
Hanford/Richland, WA	MIXED [13]
INEL/Idaho Falls, Idaho	MIXED MIXED
LANL/Los Alamos, NM	MIXED RAD
Mound/Miamisburg, OH	MIXED
ORR/Oak Ridge, TN	RAD MIXED
Rocky Flats/Golden, CO	MIXED
SRS/Aiken, SC	MIXED RAD

Regulations

Federal regulations allow the shallow burial–in specially designed landfills–of ash containing significant quantities of long-lived radioactive isotopes and toxic metals. Evidence suggests that even state-of-the-art landfills will eventually leak. [14] Yet, the regulations do not require monitoring and control of

contaminants for the length of time that ash will remain hazardous–thousands of years for some radioactive materials, and permanently, for chemically toxic metals.

Compliance Issues

State and federal regulations require comprehensive emissions testing at most once a year. By contrast, in Germany testing is required every 6 months for dioxin and furans and every week for toxic metals.

For mixed waste waste incinerators, the EPA requires a series of compliance tests designed to stress a facility's ability to meet regulations when waste inputs and temperatures are non-optimal. Routine emissions may exceed test emissions due to factors such as poor maintenance, carelessness or error on the part of the operator, and facility aging. [15]

Accident Risks

Official risk assessments generally predict accidental releases that are less than the annual regulatory limits, but actual releases have not been well documented. For a DOE mixed waste incinerator that was never operated, one assessment indicated that an explosion involving plutonium-contaminated waste could release 10 trillion times more plutonium than the DOE's predicted annual emissions. [16]

Alternatives to Incineration

Alternatives can present their own environmental problems. Landfilling liquid wastes can contaminate groundwater while storing them can lead to explosions. Emerging techniques for destroying toxic compounds such as supercritical water oxidation and plasma arc pyrolysis may prove preferable to incineration (see glossary for descriptions). However, some wastes may not be treatable by a single system, requiring separation (for example, to remove metals) before treatment.

For some existing wastes, it may be impossible to keep risks low for both current and future generations. Reducing the production of waste is therefore the surest way to minimize future health and environmental hazards.

Notes:

1. According to the Environmental Protection Agency (EPA), emissions testing "has been able to identify and quantify only as much as 60% of the organic compounds [carbon-containing chemicals of which PICs are a subset] being emitted during any test." (55 Federal Register 7153; February 21, 1991). ? Return
2. Denison, Richard, "Health and Environmental Hazards of Municipal Solid Waste Incinerator Ash," *Resource Recovery*, April 1989, pp. 14-17. ? Return
3. These are limits that apply only to new permits for incinerators burning chemically hazardous waste (although some existing incinerators may be subject to nearly equivalent standards). Permits for operating incinerators may not be up for renewal for several years. ? Return
4. The regulations do not state a risk limit for radiation, but rather a total dose limit that corresponds to some level of risk. The lower risk estimate in the text is recognized by EPA, while the higher

one is an IEER estimate more consistent with a recent study of British workers (Kendall et al; "Mortality and occupational exposure to radiation: first analysis of the National Registry for Radiation Workers," *British Medical Journal*, Vol. 304, No. 6821, 25 January 1992, pp. 220-225). ? Return

5. Schmidt, K., "Puzzling Over a Poison," US *News and World Report*, 6 April 1992, pp. 60-61. ? Return
6. For example, the German limit on dioxins and furans from incinerators is up to 10 times more stringent than the US limit (depending on the carbon to hydrogen ratio of the waste material). ? Return
7. 55 *Federal Register* 7171; February 21, 1991. ? Return
8. Emissions of some toxic PICs, such as dioxins and furans, as well as some additional metals from these incinerators will likely be regulated after November 1994, as a requirement of the Clean Air Act of 1990 (Section 129). ? Return
9. Sources: US Department of Energy; Westinghouse Hanford Company ? Return
10. Hanford=Hanford Reservation; INEL=Idaho National Engineering Laboratory; LANL=Los Alamos National Laboratory; Mound=Mound Plant; ORR=Oak Ridge Reservation; Rocky Flats=Rocky Flats Plant; SRS=Savannah River Site ? Return
11. closest population center ? Return
12. RAD-radioactive waste only; MIXED-mixed waste ? Return
13. Two mixed waste incinerators are planned for the Hanford Reservation ? Return
14. For example, see: Bonaparte, Rudolph, and Beth A. Gross, "Field Behavior of Double Linear Systems," in Bonaparte, R: (ed.), *Waste Containment Systems: Construction, Regulation, and Performance*, New York: American Society of Civil Engineers, 1990, pp. 52-83. ? Return
15. Cook, Richard J., "Incineration: Technology and Science?" paper presented at the Third Annual Symposium: Incineration of Industrial Wastes, San Diego, CA, March 1-3, 1989, 9 pp. ? Return
16. Goldfield, Joe, Niels Schonbeck, and Gale Biggs, "Rocky Flats Fluid Bed Incinerator: Exposure of Citizens due to Normal Operations and Explosions," prepared for the Sierra Club, Boulder, CO, September 1, 1987, 20 pp. ? Return

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