STATE OF PRACTICE: HOSPITAL, MEDICAL & INFECTIOUS WASTE INCINERATION

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LIST OF ABBREVIATIONS USED IN THIS REPORT

ACI	ACTIVATED CARBON INJECTION
APHA	AMERICAN PUBLIC HEALTH ASSOCIATION
CAA	CLEAN AIR ACT
CFR	CODE OF FEDERAL REGULATIONS
DOT	U.S. DEPARTMENT OF TRANSPORTATION
EG	EMISSION GUIDELINES
EPA	U.S. ENVIRONMENTAL PROTECTION AGENCY
FOIA	FREEDOM OF INFORMATION ACT
GHG	GREENHOUSE GAS
gr/dscf	GRAINS PER DRY STANDARD CUBIC FOOT
HCl	HYDROGEN CHLORIDE
Hg	MERCURY
HMIW	HOSPITAL, MEDICAL, AND INFECTIOUS WASTE
HMIWIs	HOSPITAL, MEDICAL, AND INFECTIOUS WASTE INCINERATORS
lb/hr	POUNDS PER HOUR
mg/dscm	MILLIGRAMS PER DRY STANDARD CUBIC METER

LIST OF ABBREVIATIONS USED IN THIS REPORT

MSW	MUNICIPAL SOLID WASTE
MWC	MUNICIPAL SOLID WASTE COMBUSTOR
ng/dscm	NANOGRAMS PER DRY STANDARD CUBIC METER
NO_x	NITROGEN OXIDES
NSPS	NEW SOURCE PERFORMANCE STANDARDS
PCDD/PCDF	POLYCHLORINATED DIBENZO-P-DIOXINS / POLYCHLORINATED DIBENZOFURANS
Pb	LEAD
PM	PARTICULATE MATTER
ppmv	PARTS PER MILLION BY VOLUME
RMW	REGULATED MEDICAL WASTE
SNCR	SELECTIVE NON-CATALYTIC REDUCTION
SO_2	SULFUR DIOXIDE
tpd	TONS PER DAY
tpy	TONS PER YEAR
U.S.	UNITED STATES
WHO	WORLD HEALTH ORGANIZATION

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1000 Social St., Suite 320
Raleigh, NC 27609
Phone: 919-861-6876
Email: IRP@erefdn.org
Web: www.erefdn.org

Prepared by RTI International for EREF
Questions regarding the content of this report may be directed to the corresponding authors at IRP@erefdn.org.

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EXECUTIVE SUMMARY

The management of wastes generated in healthcare, referred to in this report as medical waste, has undergone a profound regulatory and structural transformation in the United States over the past three decades. Throughout this report, the term medical waste is used to describe healthcare-generated wastes broadly, while hospital, medical, and infectious waste (HMIW) is used when referring specifically to incineration and the associated federal air quality regulatory framework. Successive federal air quality regulations promulgated under Section 129 of the Clean Air Act (CAA) fundamentally reshaped the sector, culminating in the U.S. Environmental Protection Agency's (EPA) 2013 New Source Performance Standards (NSPS) for hospital, medical, and infectious waste incinerators (HMIWIs) (CAA §129, 2024; EPA, 1997; EPA, 2009; EPA, 2013). As a result, the contemporary medical waste incineration system bears little resemblance to the decentralized, lightly controlled landscape that characterized the pre-regulatory era (Lee et al., 1991; EPA, 1997).

This assessment evaluates the modern HMIWI sector using regulatory records, facility-level permit documentation, emissions inventories, and Freedom of Information Act (FOIA) responses, rather than relying primarily on secondary literature summaries. The analysis documents four central outcomes: substantial sector contraction, sustained emissions reductions attributable to federal policy, improved environmental performance associated with centralized treatment systems, and a persistent disconnect between current operating conditions and how the sector is often characterized in academic and public discourse (EPA, 2013; NRC, 2000; PBS NewsHour, 2019).

Since the early 1990s, the number of medical waste incineration units in the United States has declined by more than 99% following implementation of CAA Section 129 standards, which imposed stringent emissions limits, operational requirements, and monitoring obligations (EPA, 1997; EPA, 2009). Thousands of small, hospital-based incinerators were retired during this period, reflecting the elimination of uncontrolled legacy units. Today, only a small number of facilities, comprising a limited set of operating units, remain active nationwide, and all identified operating HMIWIs function under modern federal standards and permitting requirements (EPA, 2013).

Facility-level regulatory data show reductions exceeding 99% for key hazardous air pollutants – including mercury (Hg), dioxins and furans (PCDD/PCDF), particulate matter (PM), acid gases, and toxic metals – relative to pre-NSPS conditions (EPA, 1997; EPA, 2009; EPA, 2013). These reductions are a direct and intended consequence of NSPS implementation, reflecting both mandatory closure of uncontrolled units and required deployment of advanced air pollution control technologies at remaining facilities. Current emissions levels are consistently well below allowable limits, and medical waste incineration no longer represents a significant national source of pollutants such as Hg that were historically of concern (EPA, 2013; EPA, 2022).

Analysis of normalized emissions performance indicates that centralized off-site commercial HMIWIs generally achieve lower emissions per unit of waste processed than remaining on-site institutional units. This pattern reflects regulatory structure rather than incidental operational differences: centralized facilities operate under permits, deploy comprehensive multi-pollutant control systems, and benefit from stable combustion conditions associated with higher throughput (EPA, 2013; Windfeld & Brooks, 2015; Zhao et al., 2009). Although sometimes described as “large,” HMIWIs remain small relative to other combustion source categories, and their emissions performance reflects the combined effects of scale, control requirements, and permitting oversight.

On-site treatment via incineration continues to serve a limited role for specific applications. For example, pathological wastes that pose a serious infectious disease risk are recommended for on-site treatment by the Centers for Disease Control and Prevention (CDC, 2023); and pathological, trace chemotherapeutic waste, and certain high-containment research materials can require secure destruction by regulation or best practice according to EPA and World Health Organization recommendations (EPA, 2013; World Health Organization, 2014). For routine medical waste streams, however, centralized off-site treatment represents the environmentally preferred model under current regulatory conditions (EPA, 2013). Transport of regulated medical waste (RMW) is governed by U.S. Department of Transportation’s hazardous materials regulations and does not represent an uncontrolled risk pathway under the modern HMIWI sector (Rutala & Mayhall, 1992).

Despite the documented regulatory transformation and emissions outcomes, legacy statistics and descriptions originating from the pre-NSPS era continue to circulate in academic literature, policy discussions, and public-facing materials, reinforcing outdated assumptions about the modern HMIWI sector (Lee et al., 1991; NRC, 2000; PBS NewsHour, 2019). These characterizations are incompatible with current standards, operating conditions, and emissions performance. The principal challenge identified in this assessment is therefore not regulatory adequacy, emissions control, or data availability – publicly accessible regulatory databases already exist – but the continued reliance on literature developed under pre-NSPS conditions that are no longer applicable to the modern HMIWI sector. Thus, the objective of this study is to update the current state of knowledge regarding contemporary medical waste incineration practices and performance.

Taken together, the findings show that the modern HMIWI sector operates under substantially different regulatory and technical conditions than those reflected in much of the legacy literature. Available facility-level and national datasets show dramatic reductions in key pollutant levels relative to pre-NSPS conditions, consistent with current regulatory requirements and operational practices. These results demonstrate the emissions performance documented in earlier studies is no longer representative of present-day HWIWI operations. Continued reliance on pre-NSPS literature risks mischaracterizing current sector performance, underscoring the need to interpret medical waste incineration impacts under contemporary data.

1. DEFINING SCOPE AND NECESSITY

The management of medical waste is central to protecting public health and the environment by mitigating exposure to infectious and hazardous materials. Medical waste includes RMW, sharps, pharmaceutical waste, pathological waste, and trace chemotherapy waste. These waste streams are generated across a broad range of healthcare and associated facilities, including hospitals, outpatient clinics, dental and veterinary offices, pharmacies, tattoo establishments, and funeral homes.

Certain categories of medical waste – particularly pathological waste, pharmaceuticals, and trace chemotherapy waste – are managed through incineration in accordance with regulatory requirements or established best practices to ensure complete destruction and effective risk mitigation. As a result, incineration remains a necessary and deliberate component of the medical waste management system, even as the overall scale of medical waste incineration has declined substantially over time.

It is important to distinguish RMW from the much larger volume of non-hazardous waste generated by healthcare facilities, such as cafeteria, office, and packaging waste, which is typically managed as municipal solid waste (MSW). Only a limited subset of healthcare-generated waste is subject to specialized handling and treatment requirements under federal and state regulatory frameworks, and this assessment focuses exclusively on that regulated subset.

This assessment integrates relevant findings from the peer-reviewed and gray literature throughout the report, rather than presenting a standalone literature review chapter. Literature is summarized where it directly informs historical context, regulatory interpretation, and comparison of management approaches.

1.1 PURPOSE OF THIS ASSESSMENT

The purpose of this assessment is to provide an updated, evidence-based characterization of medical waste management practices in the United States and to address persistent gaps between current regulatory reality and how the sector is often described in academic and public discourse. Consistent with the approach described in the Executive Summary, the assessment integrates findings from a structured review of the existing literature (Section 2) and supplements that review with original data compilation and analysis where published information is outdated, incomplete, or unavailable.

Federal regulatory requirements governing medical waste incineration have evolved substantially over the past three decades, culminating in modern NSPS, Emission Guidelines (EG), and Federal Plan requirements HMIWIs[1]. Implementation of these requirements drove profound sector contraction and substantial emissions reductions, resulting in a small number of highly regulated, well-controlled facilities operating under consistent federal oversight. Despite these changes, much of the academic and policy literature continues to rely on legacy descriptions and statistics that do not reflect post-regulatory conditions.

[1] Regulatory requirements for HMIWIs including NSPS, EGs, and Federal Plan requirements, are summarized on EPA's HMIWI program webpage: https://www.epa.gov/stationary-sources-air-pollution/hospital-medical-and-infectious-waste-incinerators-hmiwi-new.

Importantly, the challenge addressed in this assessment is not a lack of regulatory oversight, emissions control, or publicly available compliance data. HMIWIs are subject to federally enforceable standards, operating permits, and routine reporting through established EPA and state systems, and regulators rely on these records to ensure compliance under current law.

Rather, the need for this assessment arises from a persistent disconnect between the modern regulatory reality of the HMIWI sector and how it continues to be characterized in academic literature and public discourse. Legacy descriptions and statistics, often originating from pre-NSPS conditions, remain widely cited despite the adoption of standards that fundamentally altered sector structure, emissions controls, and operating practices. Addressing this perception gap requires synthesis and contextualization of existing regulatory outcomes, not new reporting systems or additional regulation.

Accordingly, this study aims to:

- Review historic and current scientific literature on medical waste management;
- Compile updated data on medical waste generation and treatment practices using regulatory records and FOIA responses;
- Evaluate emissions performance under modern federal air quality standards; and
- Compare current operational and environmental characteristics between on-site and off-site medical waste management systems.

Together, these objectives establish the foundation for the sections that follow: Section 2 examines how the literature characterizes medical waste incineration and identifies key limitations; Sections 3 and 4 reconstruct the modern HMIWI sector using regulatory and facility-level data; and Section 5 evaluates system-level implications for on-site and off-site management under post-NSPS conditions.

2. LITERATURE REVIEW OF THE ENVIRONMENTAL IMPACTS ASSOCIATED WITH HMIW MANAGEMENT

A literature review established historical context for the modern HMIW management landscape and evaluated the scope and limitations of published information relevant to the U.S. Although regulatory requirements and operational practices for medical waste incineration have evolved substantially over the past three decades, much of the published literature remains anchored in legacy information developed under pre-NSPS conditions. As a result, existing literature often does not reflect contemporary technology, emissions controls, regulatory oversight, or sector structure characterizing the modern HMIWI sector (Lee et al., 1991; NRC, 2000; EPA, 2013; RTI International, 2025).

The purpose of this section is not to synthesize emissions outcomes or evaluate regulatory effectiveness. Rather, it documents why published literature alone is insufficient to characterize post-NSPS conditions and motivates the data-driven reconstruction of the sector presented in subsequent sections. This review identifies temporal, geographic, and structural limitations in the literature that have contributed to the persistent mischaracterization of the modern HMIWI sector.

2.1 LITERATURE SEARCH SCOPE AND METHOD

The literature review encompassed both peer-reviewed academic publications and non-peer-reviewed (gray) literature, including government reports, regulatory documents, industry publications, corporate disclosures, media reporting, and other publicly available technical materials published through December 2024. Peer-reviewed sources were identified through academic databases (e.g., EBSCOhost), while non-academic materials were drawn primarily from federal and state agencies, healthcare sector datasets, investor and corporate filings, media articles, and expert consultations relevant to U.S. medical waste management practices.

From an initial global pool of approximately 1,800 publications addressing medical waste incineration, emissions, and related technologies, 362 publications were identified as potentially relevant to the U.S. context. Consistent with prior reviews (e.g., Singh et al., 2021), the majority of global studies focus on developing-country contexts – particularly in Asia and Africa – where regulatory frameworks, waste composition, technologies, and infrastructure differ markedly from those in the U.S. International studies were, therefore, retained primarily for contextual understanding, while U.S.-focused sources were prioritized for the evaluation of sector structure, regulatory drivers, and emissions performance.

Within the U.S.-relevant literature set, 101 publications appeared in peer-reviewed journals or conference proceedings, while 261 sources consisted of non-peer-reviewed published materials. Publication activity peaked between 1994 and 1999, coinciding with the widespread operation of on-site hospital incinerators and the development of initial federal emissions standards. By contrast, relatively few studies evaluate post-2013 regulatory conditions, despite substantial restructuring of the sector following implementation of modern NSPS and related requirements (EPA, 2013).

Media coverage exhibits a similar temporal pattern. Reporting intensified during the 1990s amid regulatory transitions and widespread facility closures, followed by episodic attention during public-health emergencies such as Ebola and COVID-19 or in response to localized community concerns. While some recent reporting acknowledges environmental improvements (e.g., PBS NewsHour, 2019), many articles continue to reference pre-1997 statistics or omit post-NSPS regulatory context, reinforcing outdated characterizations of current practice.

2.2 HISTORICAL DRIVERS OF CHANGE

For much of the twentieth century, medical waste in the United States was managed primarily through decentralized, on-site incineration at hospitals and other healthcare facilities. Many of these units operated with limited pollution controls, variable oversight, and routinely incinerated RMW alongside non-hazardous MSW generated onsite (Lee et al., 1991).

A major transition occurred following the expiration of the Medical Waste Tracking Act (MWTA)[2], enacted in 1988 and expired in 1991. After expiration, primary responsibility for regulating medical waste handling shifted to the states, while federal oversight increasingly focused on emissions from combustion units under the CAA (Lee et al., 1991; EPA, 1997). Subsequent federal rules established stringent emissions limits for HMIWIs, requiring installation of advanced air pollution control technologies or retirement of non-compliant units.

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[2] The MWTA of 1988 established a temporary federal tracking program for medical waste in response to public concern over mismanaged medical waste; the program expired in 1991 and did not establish permanent federal medical waste management requirements. See https://www.congress.gov/bill/100th-congress/house-bill/3515.

Federal emissions standards adopted in the late 1990s, and strengthened through subsequent revisions, including the NSPS finalized in 2013, fundamentally reshaped the sector. For many small on-site incinerators, retrofitting to meet modern standards proved economically infeasible, prompting consolidation toward a smaller number of highly controlled commercial facilities and expanded use of non-incineration treatment technologies such as autoclaving and chemical disinfection (Windfeld & Brooks, 2015; Hambrick, 2013; EPA, 2013). Figure 1 illustrates the resulting decrease in operating incinerators, including the on-site units that incinerated RMW alongside MSW as described above, over time, reflecting regulatory compliance requirements and facility closures rather than incremental operational change.

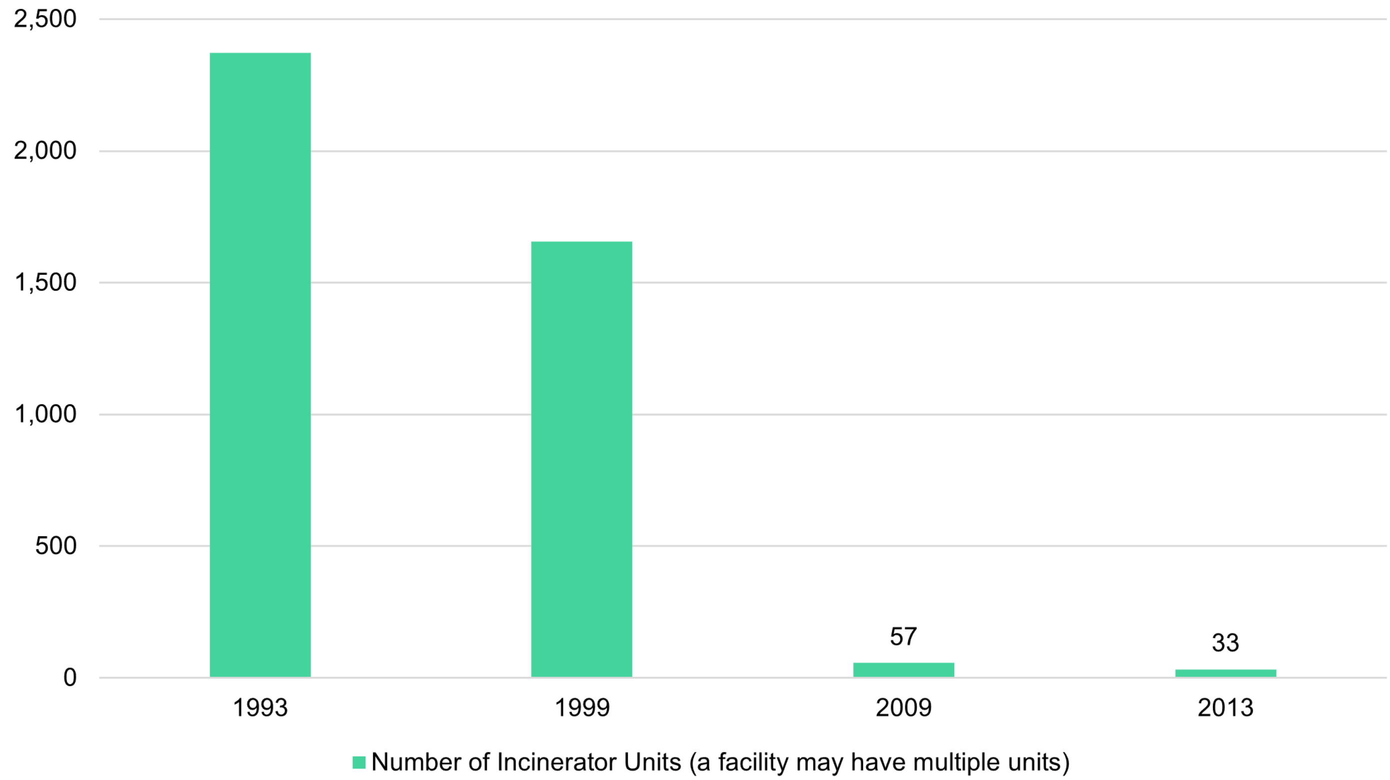

Figure 1. Trend in Medical Incinerators Operating in the U.S., 1993 – 2013.

2.3 THE PERSISTENT RELIANCE ON LEGACY DATA

Despite the regulatory and structural transformation of the sector, much of the scientific and public discourse on medical waste incineration continues to rely on legacy data developed prior to modern emissions standards. A prominent example is the continued citation of estimates suggesting that 49–60% of U.S. RMW is incinerated, figures originating from studies conducted in the 1990s and earlier (Lee et al., 1991; NRC, 2000).

More recent benchmarking indicates that the share of RMW treated through incineration is substantially lower. For example, Practice Greenhealth reported that approximately 7% of RMW was incinerated across a voluntary sample of 198 U.S. hospitals in 2013 (Practice Greenhealth, 2013). These figures are not directly comparable and should not be interpreted as quantified national reductions; rather, they indicate a clear directional shift away from incineration consistent with widespread facility closures and expanded use of alternative treatment methods (APHA, 2023; World Health Organization, 2022).

The persistence of outdated citations is documented in Table 1, which shows repeated reliance on pre-2000 studies in publications through 2025, including sources that explicitly caution against continued citation. Figure 2 further illustrates how early estimates propagate through citation chains, reinforcing outdated assumptions about the modern HMIWI sector even as the underlying regulatory and operational context has fundamentally changed.

Table 1. Continued Use of Pre-NSPS Reports and Datasets in Modern Publications.

Historical Resource	Number of Times Cited		Year of Most Recent Citation
	2014 - Present	2020 - Present	
Glasser et al. (1991)	8	5	2024
Lee et al. (1991)	18	13	2025
Lee and Huffman (1996)	32	30	2025
NRC (2000)	38	25	2025
EPA (2006)[1]	35	5	2025
Total	**131**	**78**	

[1] Includes citations of the final report and the subsequent draft update report that specifically indicates not to cite this resource.

Importantly, emissions limits, compliance data, and facility-level reporting for HMIWIs are routinely collected through federal and state regulatory programs. The principal limitation identified through this review is therefore not data availability, but lack of consolidated synthesis: relatively few studies have reconstructed the modern sector using post-NSPS regulatory and facility-level information, and outdated summaries continue to be reproduced in secondary literature.

Table 2 summarizes key historical indicators of sector change, including reductions in operating units and pollutant emissions. Changes in both unit and facility counts reflect shared regulatory drivers, particularly implementation of CAA Section 129 requirements, rather than independent or sequential processes.

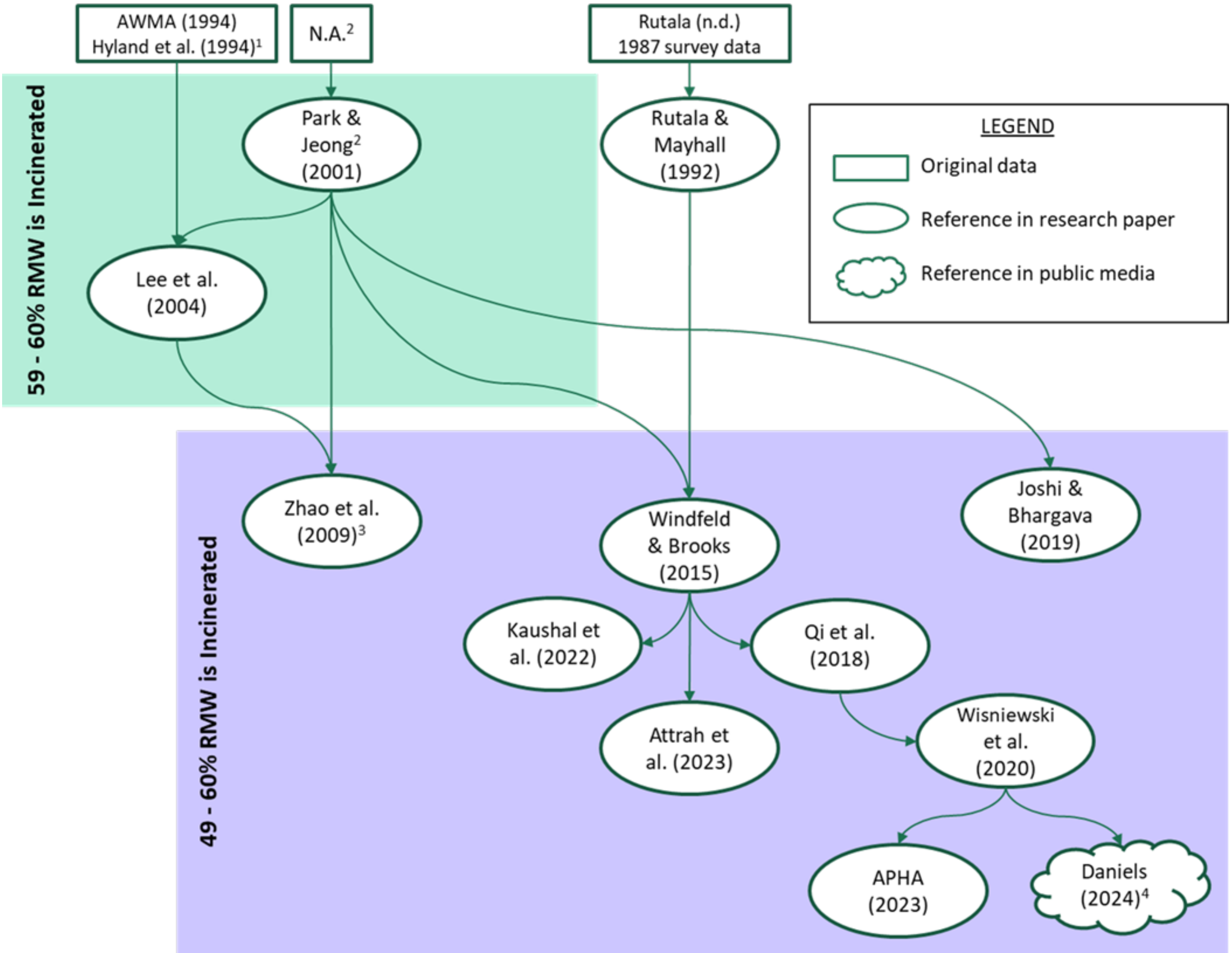

Figure 2. Citation Chain for HMIWI Statistics, percent of HMIW incinerated in the U.S.

[1] Hyland et al. (1994) is no longer in press. The corresponding AWMA committee white paper report by the same authors is available and was reviewed.

[2] Park & Jeong (2001) was the most commonly identified source for the statistic that 59-60% of RMW is incinerated. No English translation of this article is in print. The title and abstract do not suggest this study used original data to develop the statistic, as it is presented as a review paper of technology options with a focus on plasma technologies. Review of all works cited (which are in English) did not provide a source for the 59-60% statistic.

[3] Zhao et al. (2009) was the earliest identified use of 49-60% rather than 59-60%. It is attributed to Lee et al. (2004) and Park & Jeong (2001). Windfield & Brooks (2015) is the second identified use of the 49-60% statistic, but it is attributed to Park & Jeong (2001) and Rutala & Mayhall (1992). The 49% statistic is not presented in Rutala & Mayhall (1992).

[4] Daniels (2024), a website available to the general public, is one identified example of this outdated information on HMIWI being disseminated to the public.

Table 2. Historical Indicators of Change in the U.S. HMIWI Sector.

Indicator	1993 (Pre-Regulatory Era)	2013 (Post-Regulatory Baseline)	2025	Directional Change	Primary Driver
Number of HMIWI Units	~2,373[1,2]	33[3]	12[4]	Substantial decline (>99%)	CAA §129 emissions standards[1]
Number of Operating Facilities	>1,600[1,2]	27[3]	9[4]	Substantial decline (>99%)	Facility closures driven by regulatory non-viability[1]
Hg Emissions from HMIWIs [tons per year (tpy)]	~51[6]	~0.02[3,6]	<0.02[4,6]	Orders-of-magnitude reduction	Activated carbon injection (ACI) and unit closures[6,7]

[1] **Regulatory context and shared drivers.** CAA Section 129 established federally enforceable emissions standards for HMIWIs, including NSPS, EG, and Federal Plan requirements (CAA §129, 42 U.S.C. §7429; EPA, 1997; EPA, 2009; EPA, 2013).

[2] **Pre-regulatory inventories.** Estimates of unit counts, facility counts, and incineration prevalence in the early 1990s are drawn from contemporaneous EPA and academic inventories developed prior to implementation of modern federal standards (Lee et al., 1991; Strong, 1995; NRC, 2000).

[3] **2013 regulatory baseline.** Post-control baseline counts and emissions reflect facilities subject to revised NSPS and EG finalized in 2009 and fully implemented by 2013 (EPA, 2013; EPA, 2013b).

[4] **Current characterization (2025).** Current facility and unit counts are based on regulatory records and FOIA-derived facility verification conducted for this assessment (EREF, 2026).

[5] **Legacy incineration share estimates.** The frequently cited estimate that 49–60% of RMW was incinerated originates from pre-1997 studies and continues to be referenced in recent literature despite substantial sector change (Lee et al., 1991; NRC, 2000).

[6] **Hg emissions.** Hg is presented as a representative pollutant due to its historical prominence in medical waste incineration risk assessments and its stringent control under modern standards (EPA, 2006; EPA, 2013b).

[7] **Control technologies.** Emissions reductions reflect mandatory deployment of ACI and other multi-pollutant controls, combined with closure of uncontrolled legacy units (EPA, 2013; EPA, 2022).

2.4 METHODS BRIDGE: FROM LITERATURE GAPS TO DATA RECONSTRUCTION

The literature context summarized in Section 2 demonstrates that, while regulatory and facility-level data for HMIWIs are routinely collected and publicly accessible, this data has not been systematically integrated to characterize the modern HMIWI sector. In response, this assessment reconstructs current sector structure and emissions performance using regulatory records, permit documentation, emissions inventories, and FOIA-derived facility verification rather than secondary literature summaries.

The analytical approach applied in subsequent sections focuses on identifying operating facilities subject to modern federal standards, compiling reported emissions and control technologies, and evaluating post-NSPS performance using primary regulatory sources. This approach directly addresses the reliance on legacy information identified in the literature and provides an evidence-based characterization of contemporary medical waste incineration practices.

3. SYNTHESIS OF HMIWI EMISSIONS DATA

This section presents an original synthesis of regulatory and facility-level data to characterize the modern HMIWI sector in the United States. Building on the limitations of published literature identified in Section 2, the analysis relies on regulatory records, permit documentation, emissions inventories, and FOIA-derived records rather than secondary literature summaries (EREF, 2026). The purpose of Section 3 is descriptive: it documents the structure of the operating sector, the regulatory requirements that apply to it, and the facility-level emissions limits and reported values available in regulatory records. Interpretation of policy-driven sector change and quantified pre-/post-NSPS outcomes is addressed in Section 4.

Consistent with this descriptive purpose, Section 3 summarizes the governing regulatory framework (Section 3.1), describes modern incinerator configurations and control technologies implemented to meet those standards (Section 3.2), presents the FOIA-verified facility inventory (Table 3; Section 3.3), and summarizes permit limits and reported emissions values for the operating universe (Table 4; Section 3.4). Section 3 concludes with a brief overview before transitioning to the policy-focused analysis in Section 4 (Section 3.5).

3.1 REGULATORY FRAMEWORK AND STANDARDS GOVERNING HMIWIS

HMIWIs are regulated under CAA Section 129 requirements and associated implementing regulations, including NSPS, EG, and Federal Plan provisions (42 U.S.C. §7429; 40 C.F.R. §60.50c–60.58c; EPA, 2009; EPA, 2025c). Operating HMIWIs are subject to federally enforceable emissions limits for nine regulated pollutants, along with monitoring, reporting, and operational standards intended to ensure consistent emissions control across facilities (EPA, 2010; EPA, 2025c).

Facilities subject to Section 129 requirements are implemented and enforced through state and federal permitting programs, including the CAA Title V operating permit program, which consolidates federally enforceable emissions limits, monitoring requirements, and operational conditions into a single public-facing permit and establishes ongoing compliance obligations (EPA, 2011). While Title V is a single permitting framework, facilities are categorized based on potential emissions, with higher throughput facilities typically permitted as major sources and others operating as synthetic minor or non-major sources under enforceable limits. Title V is the primary framework through which emissions limits and monitoring requirements are implemented and enforced for HMIWIs.

Other incinerator types may be permitted to treat limited quantities of RMW under different CAA source categories, including municipal solid waste combustors (MWCs) that burn less than 10% RMW and certain hazardous waste incinerators authorized to accept medical waste (EPA, 2023a; EPA, 2025c). These units are regulated under distinct standards and are not classified as HMIWIs. They are excluded from the HMIWI facility inventory summarized in Table 3 but are acknowledged here to prevent misinterpretation of sector scope.

3.2 MODERN INCINERATOR CONFIGURATION AND CONTROL TECHNOLOGIES

Before presenting facility inventories and emissions data, this section describes the incinerator configurations and air pollution control technologies commonly implemented at operating HMIWIs to meet modern regulatory requirements. This context is necessary for interpreting the emissions limits and reported values summarized in Table 4.

Control technologies implemented across the operating sector include:

- Dual-chamber combustion systems to promote complete oxidation and stable operation (EPA, 2009);
- Fabric filters (baghouses) for PM and metal control (NRC, 2000);
- ACI, including sulfur-impregnated carbon, for control of Hg and PCDD/PCDF (NRC, 2000; Envitech, 2013);
- Wet and dry scrubber systems for acid gas control [hydrogen chloride (HCl) and sulfur dioxide (SO2)] (Envitech, 2013; EPA, 2025c); and
- Selective non-catalytic reduction (SNCR) systems at higher-throughput commercial facilities for nitrogen oxides (NOx) control (EPA, 2023a).

All operating facilities maintain permits and are subject to monitoring, recordkeeping, and reporting requirements (EPA, 2011). Permitted waste streams are limited to RMW and closely related materials (e.g., pathological waste, trace chemotherapeutic waste, and certain non-hazardous pharmaceuticals) consistent with federal applicability determinations (40 C.F.R. Part 60, Subpart Ec; EPA, 2025c). Hazardous waste and radioactive materials are excluded from permitted waste streams.

3.3 FACILITY INVENTORY AND OPERATIONAL STATUS (FOIA-BASED)

Facility inventories presented in this report are derived from FOIA responses obtained in 2025 and were supplemented by cross-checks against federal and state permitting databases (EREF, 2026). The analysis screened 60 candidate facilities identified from regulatory records and historical listings, and reconciled their operational status using permits, emissions inventories, and FOIA correspondence. Based on this reconciliation, nine facilities were confirmed as operating HMIWI sources, comprising a total of twelve incineration units, as summarized in Table 3 (EREF, 2026). In contrast, twelve facilities were confirmed as not operational, five were determined not to be HMIWI sources (e.g., combustors regulated under other CAA source categories), and seven were closed or decommissioned but retained limited historical documentation. Several additional facilities represented special-case combustors, including pathological- or animal-waste-only units and co-fired combustors operating under alternative applicability provisions. These distinctions explain discrepancies among facility counts reported in public databases, mapping tools, and prior literature (EPA, 2013; EPA, 2025b).

The operating universe consists primarily of off-site commercial operations with higher permitted capacity, supplemented by a limited number of specialized on-site institutional units located at major medical or research campuses, as reflected in the aggregated characteristics presented in Table 3. For clarity and consistency, the main text emphasizes aggregated findings and sector-wide patterns; facility-identifying details, permit action dates, and unit-level documentation are provided in the FOIA dataset (EREF, 2026). All tables indicate the reporting year(s) associated with the summarized data, recognizing that timing is central to the interpretation of reported emissions and permit applicability.

Table 3. FOIA-Verified Profile of Operating U.S. HMIWI Facilities and Units (2025).

Facility Category	Facilities (Active)	Units (Active)	Share of Units (%)	Permitted Capacity Range (lb/hr)[1]	Typical Primary Control Train (examples)	Typical Permit Status[2]
Off-site commercial HMIWI facilities	6	9	75%	~1,500–7,000	SNCR (at higher-throughput units) + dry/wet scrubbers + ACI + fabric filter	Title V (mix of major and minor/non-major)
On-site institutional HMIWI facilities	3	3	25%	~100–1,500	Dual-chamber combustion + scrubber and/or quench + fabric filter (controls vary by unit)	Title V (typically minor/non-major)

[1] Capacity is the permitted design or maximum charging rate, as reported in permits/FOIA records; capacities are not directly comparable to throughput in a given year and should be interpreted as nameplate/permitted limits rather than annualized utilization.

[2] Title V status varies by site and state program (major vs minor/non-major/synthetic minor). This table reports typical patterns observed in the FOIA-compiled inventory; facility-specific determinations are provided in the supporting dataset (EREF, 2026).

Timing note: Permit action dates and emissions reporting years vary across facilities and units. The FOIA-compiled dataset used for this assessment reflects the most recent permit information available in the record set and the emissions reporting year(s) available for each unit. Facility-specific permit action dates, expiration dates (where applicable), and the year(s) of reported emissions data are documented to support independent verification (EREF, 2026).

3.4 EMISSIONS LIMITS AND REPORTED PERFORMANCE

Emissions information summarized in this section is derived from facility-level permit conditions and reported emissions values obtained through FOIA responses and regulatory databases (EREF, 2026; EPA, 2018). This data reflects emissions limits established under NSPS and related CAA Section 129 requirements, alongside the reported emissions values available for the corresponding reporting years (EPA, 2009; EPA, 2025c).

Rather than focusing on individual pollutants in isolation, this section summarizes permit limits and reported values across the full suite of regulated constituents. As shown in Table 4, operating HMIWI units report emissions values below permitted limits for PM, acid gases, metals, and organic pollutants in the years available in the compiled record set, consistent with the control configurations described in Section 3.2 (NRC, 2000; EPA, 2025c).

Table 4 presents aggregated data, highlighting the ranges of permit limits and reported values across the operating sector. As shown in Table 4, HMIWI permit emissions limits are typically expressed as concentration-based values (e.g., ppmv, mg/dscm, ng/dscm), while reported emissions are presented as annual mass (tpy) for inventory and regulatory purposes. Conversion between these units is therefore required for direct comparison. Facility- and unit-specific values, associated reporting years, and permit references are reported in the FOIA dataset to allow timing-sensitive interpretation and independent verification (EREF, 2026).

Table 4. FOIA-Derived Emissions Limits and Reported Emissions for Operating HMIWI Units.

Pollutant / Metric	Regulatory Form Used in Permits	Typical Permit Emission Limit (Range Observed)[1]	Reported Emissions (tpy) in Available Records (Range Observed)[2]
PM	mg/dscm (and/or gr/dscf equivalents)	~25–69 mg/dscm	~0.11–3.24 tpy
CO	ppmv	~5.5–40 ppmv	~0.15–3.78 tpy[3]
PCDD/PCDF	ng/dscm (total and/or TEQ formats vary)	~0.85–125 ng/dscm (format varies by permit)	~3.2E-08–2.8E-06 tpy[3]
HCl	ppmv	~0.85–125 ppmv	~0.04–6.57 tpy[3]
SO_2	ppmv	~6.6–15 ppmv	~0.03–6.37 tpy[3]
NO_x	ppmv	~4.2–125 ppmv	~0.79–79.1 tpy[3]
Pb	mg/dscm	~0.018–1.2 mg/dscm	~0.000203–0.00217 tpy[3]
Cd	mg/dscm	~0.0092–0.16 mg/dscm	~0.0000385–0.001 tpy[3]
Hg	mg/dscm	~0.0013–0.55 mg/dscm	Not consistently reported in tpy across units[4]

[1] Limits shown reflect the forms and units used in facility permits (e.g., mg/dscm, ppmv, ng/dscm). Limit formats may differ across state programs and permitting actions; preserves the unit-level values as documented (EREF, 2026).

[2] Reported emissions (tpy) are presented only where available in the compiled record set (e.g., FOIA responses, permit materials, or associated emissions inventory documentation). “Not specified” or “not reported” values are not imputed. This table is intended to summarize the range of reported values across operating units, not to imply uniform reporting completeness (EREF, 2026).

[3] Where reported

[4] Hg reporting completeness varies in the available unit-level records and is not consistently expressed in tpy across all units in the compiled dataset. Where Hg emissions are reported, they are documented at the unit level (EREF, 2026).

Notes:

On special-case unit classification. The compiled dataset includes one operational small, on-site co-fired combustor permitted under the HMIWI source category, with 40 C.F.R. Part 60, Subpart Ec listed as applicable and permitted waste streams including RMW co-fired with MSW. It is therefore included in the FOIA-verified operating HMIWI inventory (EREF, 2026).

Facility-specific permits and emissions reporting years vary; the FOIA dataset provides the unit-level year(s) for all reported values (EREF, 2026).

3.5 FROM SECTOR DESCRIPTION TO POLICY-OUTCOME ANALYSIS

The regulatory and facility-level synthesis presented in Section 3 establishes the operating universe of HMIWIs under post-NSPS conditions, including applicable standards, typical control configurations, and the ranges of permit limits and reported emissions values available in regulatory records (EREF, 2026). These descriptive findings provide the empirical foundation for the policy-focused evaluation in Section 4, which examines how implementation of CAA Section 129 requirements, including the NSPS framework, produced the observed sector structure and emissions outcomes relative to pre-NSPS conditions.

4. HMIWI EMISSIONS AND THE RESPECTIVE IMPACT OF NSPS POLICY

This section evaluates how implementation of CAA Section 129 requirements, operationalized through the dual NSPS framework, produced the sector structure and emissions outcomes observed under post-NSPS conditions (42 U.S.C. §7429; EPA, 2009; EPA, 2025c). Where Section 3 is descriptive (facility universe, control configurations, permit limits, and reported values), Section 4 is evaluative: it links observed outcomes to regulatory design and implementation and quantifies directional changes between pre-NSPS conditions and the modern HMIWI sector using EPA emissions inventories, permit data, and FOIA-derived records (EPA, 1997; EPA, 2018; EREF, 2026).

4.1 THE DUAL NSPS REGULATORY FRAMEWORK (SUBPARTS CE AND EC).

Under Section 129 of the CAA, EPA regulates HMIWIs through two complementary regulatory pathways codified in 40 CFR Part 60 (EPA, 2009; EPA, 2025c):

- Subpart Ce – EG applicable to existing HMIWI units constructed on or before June 20, 1996; and
- Subpart Ec – NSPS applicable to new, modified, or reconstructed HMIWI units constructed after June 20, 1996.

Table 5 highlights subparts Ce and Ec and how they together, establish parallel compliance pathways based on unit construction date and modification status while regulating the same nine pollutants: PM, CO, Pb, Cd, Hg, PCDD/PCDF, HCl, NO_x, and SO_2 (40 C.F.R. §§60.33e, 60.52c; EPA, 2009). These standards were first promulgated in 1997 (62 FR 48348, 1997) and were subsequently revised through EPA's 2009 amendments (74 FR 51368, 2009), which strengthened limits and implementation requirements and were fully implemented beginning in 2010 (EPA, 2010; EPA, 2013).

Table 5. Clean Air Act Section 129 Subpart Ce and Ec Regulatory Framework.

Feature	Subpart Ce (EG)	Subpart Ec (NSPS)
Applicability	Existing HMIWI units constructed on or before June 20, 1996	New, modified, or reconstructed HMIWI units after June 20, 1996
Modification Rule	Compliance-driven modifications do not trigger Subpart Ec	Units must meet full NSPS requirements
Regulated Pollutants	Nine pollutants: Cd, CO, HCl, Pb, Hg, NO_x, PM, PCDD/PCDF, SO_2	Same nine pollutants
Exclusions	Applies to MWCs < 250 tpd burning >10% HMIW	Same; excludes cement kilns burning HMIW

In addition to numeric emissions limits, the framework includes operational and compliance requirements (e.g., operator training/certification, waste management planning, stack testing, monitoring, recordkeeping, and reporting) intended to ensure sustained emissions control rather than episodic compliance (40 C.F.R. §§60.53c–60.58c; EPA, 2009).
As noted in Section 3, other combustors may accept limited quantities of RMW under different CAA source categories (e.g., MWCs burning <10% RMW or certain hazardous waste incinerators), but these are regulated under distinct standards and are not classified as HMIWIs (EPA, 2023a; EPA, 2025c). They are excluded from the emissions comparisons presented here to prevent misinterpretation of sector scope.

4.2 SECTOR SCOPE AND CLARIFICATION OF FACILITY COUNTS

In 2010, the EPA estimated that approximately 54 existing HMIWI units remained subject to amended federal standards following widespread closures associated with implementation of revised requirements (74 FR 51368, 2009; EPA, 2013). To reconcile legacy unit counts and historical listings with current operations, this assessment compiled and screened a candidate universe of 60 facilities using federal, state, and institutional records (EREF, 2026). The candidate universe intentionally included facilities with incomplete documentation (e.g., no FOIA response), facilities determined to be closed or non-operational, and facilities ultimately determined not to be HMIWI sources (e.g., units regulated under other CAA source categories or special-case combustors) to transparently resolve misclassifications and legacy identifiers.

As documented in Section 3, FOIA responses and permit verification confirm that nine facilities comprising twelve total units were operating under HMIWI-specific applicability during the 2020–2024 reporting period (EREF, 2026). Unless otherwise specified, emissions outcomes evaluated below reflect the active post-NSPS sector (the FOIA-verified operating universe), while pre-NSPS comparisons draw on EPA inventories and regulatory baselines developed when the sector contained substantially more units (EPA, 1997; EPA, 2018).

4.3 OBSERVED ENVIRONMENTAL OUTCOMES UNDER NSPS

Emissions information compiled from EPA inventories and facility-level permitting records indicate that emissions reductions under the NSPS framework are driven by two linked mechanisms: (1) closure of uncontrolled or economically non-viable legacy units and (2) mandatory deployment and operation of multi-pollutant control technologies at remaining facilities (EPA, 1997; EPA, 2009; EPA, 2018; EREF, 2026). The combined effect is a modern operating sector with substantially reduced unit counts and markedly lower emissions intensity relative to pre-NSPS conditions.

Table 6 summarizes pollutant-specific directional changes using the best-available pre-NSPS baselines and post-NSPS values reported in FOIA inventories and permits, including only those cases for which the dataset was sufficiently complete and comparable across post-NSPS facilities. These values are intended to characterize the order-of-magnitude change and the regulatory drivers of that change, recognizing that reporting formats and inventory methods vary across years and sources (EPA, 2018; EREF, 2026).

Table 6. HMIWI Emissions Reductions Under the NSPS Framework: Pre-NSPS Baseline vs. Post-NSPS Reported Emissions for the FOIA-Verified Operating Sector (2025).

Pollutant	Pre-NSPS baseline emission limits (inventory / rulemaking-era sector characterization) (tpy)	Post-NSPS reported emissions for FOIA-verified operating HMIWI sector (tpy)	Percent reduction	Primary driver under NSPS framework
Hg	51	<0.02[1]	99.96%	ACI + Closure[3]
PCDD/PCDF	~0.00794[2]	~1.4E-6[3]	99.98%	Combustion Optimization + ACI[3]
PM	1,036[2]	~1.27[3]	99.88%	Baghouse Filtration[3]
HCl	6,283[2]	~1.82[3]	99.97%	Scrubber Systems[3]

[1] (EPA, 2018; Butler et al., 2008).
[2] (EPA, 1997). Converted from Mg per year to tpy.
[3] (EREF, 2026).

4.3.1 AIR TOXICS

The pollutants historically associated with the greatest localized health concerns – particularly Hg and PCDD/PCDF – show the most pronounced declines in available national inventory and facility-level records. These compounds are known or suspected to cause cancer or other serious health effects, even at low concentrations. These declines are consistent with the NSPS framework's combined effects: eliminating uncontrolled units and requiring robust control trains (e.g., ACI, scrubbers, and filtration) at remaining facilities (NRC, 2000; EPA, 2009; EPA, 2018; EPA, 2025c; EREF, 2026):

- Hg: Reported Hg emissions declined by approximately 99.96% relative to pre-NSPS baseline conditions, reflecting mandatory deployment of ACI, improved combustion control, healthcare mercury-reduction initiatives, and closure of small on-site incinerators that historically lacked effective controls (NRC, 2000; EPA, 2009; EPA, 2018; EREF, 2026). As demonstrated by Figure 3, HMIWIs no longer represent a significant national source of Hg emission under post-NSPS conditions.
- PCDD/PCDF: Emissions declined by approximately 99.98%, consistent with high-temperature combustion requirements, rapid quench practices, and carbon adsorption controls mandated under NSPS (EPA, 2006; EPA, 2013b; Windfeld & Brooks, 2015; Bolan et al., 2023).
- Other Air Toxics (Pb, Cd, HCl, SO_2): Reductions exceeding 99% are observed across metals and acid gases, consistent with widespread adoption of fabric filters, scrubber systems, and strengthened waste segregation and operating requirements under CAA Section 129 standards (EPA, 2018; Emad et al., 2023).

These reductions are consistent with the regulatory logic described in NSPS rulemaking analyses, which anticipated that the largest reductions would result from unit retirements and mandatory control deployment rather than incremental tightening applied to a large remaining fleet (EPA, 2009; EPA, 2010).

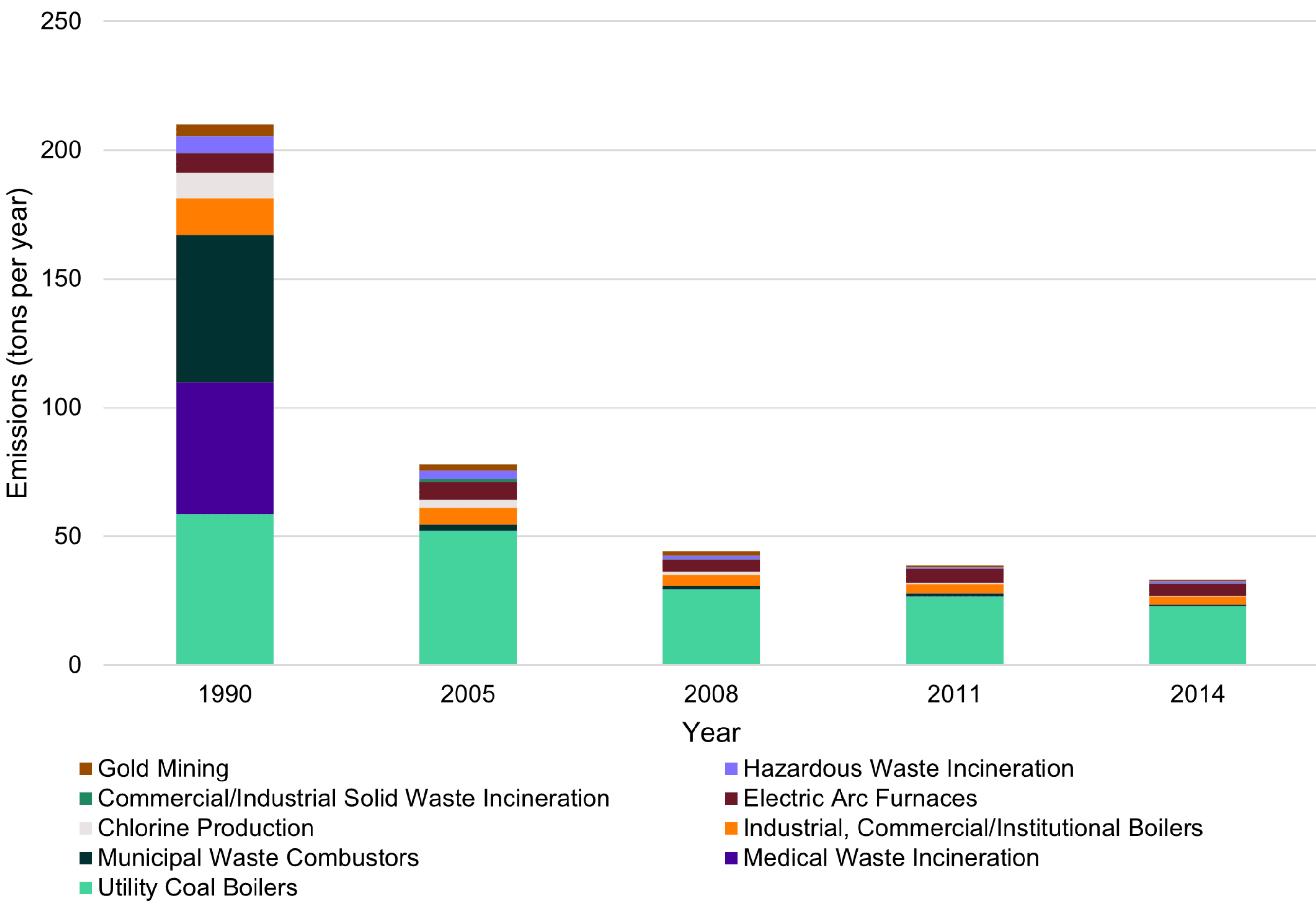

Figure 3. Anthropogenic Hg Emissions in the U.S., by Source Category (EPA, 2018).

4.3.2 CRITERIA AIR POLLUTANTS

Criteria pollutants and combustion performance indicators also reflect substantial improvement under post-NSPS conditions. These common and widespread pollutants are regulated for overall air quality. For example:

- **PM:** PM emissions declined by approximately 99.88% relative to pre-NSPS conditions reflecting the near-universal use of fabric filters, with current reported emissions consistently well below permitted limits (EPA, 1997; EPA, 2018; EREF, 2026).
- **NO_x:** NO_x emissions declined by an estimated 98%, reflecting combustion optimization and adoption of SNCR at higher-capacity commercial facilities (EPA, 1997; EPA, 2023a).

Across criteria pollutants, the persistence of emissions well below permitted limits in available reporting years indicates that required control technologies and operational standards are effective in maintaining low emissions on an ongoing basis, rather than emissions reductions being dependent on voluntary operational practices (EPA, 2025c; EREF, 2026).

4.4 GREENHOUSE GAS (GHG) CONTEXT

While NSPS does not regulate GHGs, estimated carbon dioxide–equivalent emissions from active HMIWIs are less than 0.1 million metric tpy, negligible relative to emissions from the broader waste management sector (EPA, 2023b; EREF, 2026). Because air toxics and criteria pollutants are tightly controlled, remaining environmental considerations for this sector are more closely tied to system configuration and waste management logistics than to further reductions in stack emissions.

4.5 INTERPRETATION AND IMPLICATIONS

The emissions outcomes summarized in this section indicate that implementation of CAA Section 129 requirements through the dual NSPS framework produced a modern HMIWI sector that is substantially smaller and operates under stringent, federally enforceable standards. The dominant drivers of change were structural and regulatory: retirement of uncontrolled or economically non-viable legacy units and required implementation of multi-pollutant controls and compliance programs at remaining facilities (EPA, 2009; EPA, 2018; EREF, 2026).

Consistent with the Executive Summary and Section 1 framing, the principal challenge identified is not regulatory adequacy, emissions control, or absence of publicly accessible compliance data. Emissions limits, permitting records, and reporting mechanisms already exist through EPA and state systems. Rather, the challenge is a persistent disconnect between current operating conditions and prevailing academic and public characterizations that continue to rely on legacy, pre-NSPS descriptions and statistics (EPA, 2013; EREF, 2026).

5. ON-SITE AND OFF-SITE MEDICAL WASTE INCINERATION IN THE POST-NSPS SYSTEM

This section evaluates the respective roles of on-site institutional incineration and off-site commercial incineration within the modern HMIWI sector under post-NSPS conditions. Building on the facility inventory and emissions outcomes documented in Sections 3 and 4, the discussion focuses on system configuration, regulatory oversight, normalized emissions performance, and logistical considerations, including transportation of RMW. The purpose of this section is not to re-evaluate emissions controls, which are addressed in detail in Section 4, but to assess how the current dual system functions in practice and to clarify persistent claims regarding relative environmental performance and transportation risk using regulatory records and FOIA-derived data (EREF, 2026).

5.1 INCINERATION SYSTEM TYPES AND SCALE CONTEXT

Typical HMIWI capacities range from approximately 18 to 84 tons per day, which is orders of magnitude lower than MWCs (defined federally as units exceeding 250 tons per day) or large hazardous waste incinerators, which may process several hundred tons per day (EPA, 2009; EPA, 2025c). This scale distinction is important for contextualizing emissions performance and regulatory oversight: HMIWIs represent a comparatively small and narrowly scoped combustion class despite their role as centralized service providers.

Off-site commercial HMIWIs are typically permitted as Title V major sources, reflecting higher throughput and continuous operation, whereas on-site institutional units are more commonly permitted as Title V synthetic minor or non-major sources, operating under enforceable limits that constrain potential emissions (EREF, 2026). These permitting distinctions directly shape monitoring, reporting, and control requirements and are central to understanding comparative performance.

Table 7 summarizes key differences in throughput, control configurations, and regulatory oversight between on-site and off-site HMIWI configurations under post-NSPS conditions.

Table 7. Comparison of On-Site vs. Off-Site HMIWI Configurations (Post-NSPS).

Criterion	On-Site Facilities (Institutional)	Off-Site Facilities (Commercial)	Off-Site Environmental Assessment
Throughput capacity	Lower throughput; often batch or intermittent operation	Higher throughput; continuous-flow systems	Larger scale supports stable combustion and consistent control performance (EPA, 2009).
Emissions control configuration	Simpler air pollution control devices typical	Multi-pollutant control trains (e.g., fabric filters, ACI, scrubbers, SNCR)	Greater control sophistication and redundancy at scale result in lower normalized emissions (EPA, 2009; WHO, 2014).
Energy recovery	Rare or absent	More common in commercial facilities	Scale enables waste heat recovery and improves thermal efficiency where implemented (NRC, 2000).
Regulatory oversight	Often permitted as Title V synthetic minor or non-major sources	Typically permitted as Title V major sources	Major-source permitting requires more frequent monitoring, testing, reporting, and public transparency (EPA, 2012).
Prevalence	5 confirmed operational, including 2 co-fired units	Dominant model, 6 confirmed operational with significantly more capacity	Off-site is environmentally preferred model under current regulatory conditions.
Specialized o applications	Pathological waste, high-containment research materials, secure destruction needs	Broad healthcare system waste streams	On-site incineration persists for specific unique circumstances to manage high risk materials (CDC, 2023; WHO, 2014).

5.2 TRANSPORT OF RMW AND PUBLIC HEALTH PERCEPTION

Claims that off-site management of RMW pose disproportionate public health risks from transportation are not supported by the regulatory framework governing medical waste movement. Transport of RMW in the United States is regulated under U.S. DOT's hazardous materials regulations, which specify packaging, labeling, vehicle requirements, transporter permitting, incident response procedures, and are subject to inspection and enforcement (EPA, 2009; World Health Organization, 2014).

Within this framework, transportation represents a regulated and controlled component of medical waste management rather than an unmanaged risk pathway. Available regulatory and technical literature indicates that, under modern controls, the primary environmental and public-health concerns associated with medical waste incineration relate to combustion-generated air emissions, rather than transportation (EPA, 2009; World Health Organization, 2014). The compiled regulatory record provides no evidence that regulated transport compromises the environmental or public-health performance of centralized off-site treatment systems.

5.3 EMISSIONS PERFORMANCE AND REGULATORY OVERSIGHT

Comparative environmental performance is most appropriately evaluated using normalized emissions intensity (e.g., pollutant mass per ton of waste processed) rather than absolute emissions. Regulatory records and FOIA-derived data indicate that off-site commercial HMIWIs consistently achieve lower normalized emissions intensity than on-site institutional units (EREF, 2026).

This pattern reflects structural and regulatory differences, not voluntary operational practices. Off-site commercial facilities are required to deploy comprehensive multi-pollutant control trains – typically including fabric filters, wet or dry scrubbers, ACI, and, at higher throughput levels, SNCR for NO_x – and to operate under Title V major source permits that require enhanced monitoring, periodic stack testing, routine reporting, and public transparency (EPA, 1997; EPA, 2009; EPA, 2012; World Health Organization, 2014).

On-site institutional units, while subject to enforceable permit conditions, typically operate with simpler control configurations and under narrower monitoring and reporting requirements consistent with their lower throughput and constrained permitted emissions (EREF, 2026). The comparative attributes summarized in Table 7 illustrate how differences in scale and permitting structure translate directly into differences in control sophistication and oversight.

5.4 ROLE OF ON-SITE INSTITUTIONAL INCINERATION

On-site institutional incineration continues to play a limited role within the modern HMIWI system. Of the five confirmed operational facilities, their capacity is substantially less than off-site units due to the small size of existing units and the co-fired operation of several units. These units are likely retained due to unique circumstances and investments or where pathological waste and certain high-containment research materials warrant immediate destruction. Their continued operation does not reflect environmental performance advantages for medical waste.

Accordingly, on-site incineration should be understood as a niche application within a system that otherwise relies on centralized, highly controlled off-site facilities for routine medical waste management.

5.5 SYSTEM-LEVEL IMPLICATIONS

The post-NSPS medical waste incineration system, characterized by a small number of tightly regulated off-site commercial facilities complemented by highly limited on-site institutional units, represents a stable and deliberate regulatory outcome. The compiled evidence does not support legacy claims that on-site incineration is environmentally superior for routine waste streams or that off-site transport introduces disproportionate risk (EPA, 2009; World Health Organization, 2014; EREF, 2026).

Instead, the data show that centralization, under modern regulatory controls, has produced lower normalized emissions, more consistent oversight, and improved environmental performance, while preserving on-site capacity where it is operationally preferred. As summarized in Table 7, the current configuration reflects intentional regulatory design under CAA Section 129 requirements rather than an interim or suboptimal state.

6. KEY FINDINGS

This assessment provides an updated characterization of the U.S. HMIWI sector and documents a profound regulatory and structural transformation, driven by successive EPA rulemakings under Section 129 of the CAA, culminating in full implementation of the 2013 NSPS (EPA, 2009; EPA, 2013). This sector transitioned away from a decentralized system dominated by small, hospital-based incinerators with limited controls, to a small number of centralized facilities operating under uniform federal performance standards, with compliance implemented and enforced through Title V (EPA, 2009; World Health Organization, 2014).

Implementation of NSPS, EG, and associated CAA requirements resulted in widespread retirement of uncontrolled legacy units and mandatory deployment of advanced, multi-pollutant air pollution control technologies at remaining facilities EPA, 2009; EPA, 2010). Emissions reductions exceeding 99% for key hazardous pollutants – including mercury and dioxins/furans – are a direct and intended outcome of this regulatory framework, reflecting structural change and enforceable control requirements rather than incremental operational adjustments or voluntary measures, although reported emissions well below limits may reflect voluntary investments to further limit emissions (NRC, 2000; EPA, 2009).

A central conclusion of this assessment is the apparent misalignment between current sector performance and prevailing public characterization based on outdated scientific studies. Legacy statistics and descriptions originating from pre-NSPS conditions continue to be cited despite the adoption of standards that fundamentally altered sector structure, emissions controls, and operating practices. This disconnect is evident from the regulatory record alone, the standards governing modern HMIWIs are incompatible with the operating assumptions embedded in much of the older literature (EPA, 2009; World Health Organization, 2014).

Importantly, this misalignment does not arise from an absence of regulatory oversight or compliance data. Publicly accessible regulatory systems, including EPA and state permitting databases, emissions inventories, and enforcement records, already exist and are routinely used by regulators to ensure compliance under current law. As with many regulated sectors, assembling a consolidated national picture requires synthesis from multiple systems, however, this reflects the structure of environmental regulation rather than any deficiency in regulatory rigor or sector performance. The evidence compiled in this assessment indicates that operating HMIWIs are meeting applicable federal requirements and maintaining emissions well below permitted limits (EPA, 2009; EPA, 2018).

Therefore, a key finding from this research is not the need for new reporting systems or additional regulation, but the need for clearer alignment between perception and documented regulatory outcomes. Continued reliance on outdated characterizations discounts demonstrated regulatory success and misrepresents the environmental performance of the modern HMIWI sector. Accurate understanding of the outcomes of NSPS adoption – such as sector contraction, centralized treatment, mandatory deployment of advanced controls, and sustained emissions reductions – better reflect current operating conditions and support evidence-based discussion of medical waste management (EPA, 2009; NRC, 2000; World Health Organization, 2014).

Overall, the evolution of the HMIWI sector illustrates how development of emissions standards can drive structural change, eliminate high-risk legacy practices, and deliver long-term environmental benefits within a specialized industrial system. The post-NSPS HMIWI sector is small, highly regulated, and environmentally controlled, and its performance should be understood in this contemporary regulatory context rather than through the lens of historical practice.

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