

US EPA ARCHIVE DOCUMENT

**ENVIRONMENTAL PROTECTION AGENCY**

**40 CFR Parts 260, 261, 264, 265, and 266**

**[EPA/OSW-FR-92-SWH-FRL-4198-5]**

**Burning of Hazardous Waste in Boilers and Industrial Furnaces**

**AGENCY:** Environmental Protection Agency (EPA).

**ACTION:** Final rule; technical clarification amendments and corrections.

**SUMMARY:** This action makes several technical clarification amendments and corrections to the final rule for boilers and industrial furnaces burning hazardous waste. The final rule was published on February 21, 1991 (56 FR 7134). These revisions provide clarification and correct unintended consequences of the rule.

**EFFECTIVE DATE:** August 11, 1992.

**ADDRESSES:** The documents are available for viewing at the RCRA Information Center (docket identification number F-92-BBC3-FFFFF), located at: EPA/RCRA Information Center, room M2427, 401 M Street, SW., Washington, DC 20460.

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**B. Technical Corrections**

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**A. Technical Clarification Amendments**

On February 21, 1991, the Agency published a final rule which regulates the burning of hazardous waste in boilers and industrial furnaces (BIFs). See 56 FR 7134. The rule controls emissions of toxic organic compounds, toxic metals, hydrogen chloride, chlorine gas, and particulate matter from BIFs that burn hazardous waste. In addition, the rules subject owners and operators of BIFs to the general facility and permitting standards applicable to hazardous waste treatment, storage, and disposal facilities.

After publication of the rule, the Agency received many questions and requests for clarification on certain provisions of the rule. In addition, in a number of cases, the Agency was questioned as to whether the rule as promulgated truly reflected the Agency's intent. As a result of these questions and as a result of the Agency's own review, the Agency published a technical amendment to the rule to clarify the operation of the regulation and to correct certain unintended consequences. Those amendments were published at 56 FR 42504 on August 27, 1991. (Note that EPA had previously published several other technical

corrections and amendments to the February 21 final rule (56 FR 32688 (July 17, 1991).)

As facilities began to comply with the BIF rules, additional questions have been raised about the way various provisions of the rule are intended to work. Today's technical clarification amendments address those questions.

*1. The Definition of Baseline Hydrocarbon Level for Industrial Furnaces Complying With the Alternative Hydrocarbon Limit Is Clarified To Require Consideration of Process Variability*

The Cement Kiln Recycling Coalition (CKRC) has expressed concern to the Agency that the alternative hydrocarbon (HC) provision of the rule is problematic for furnaces that feed raw materials containing naturally-occurring organic matter.<sup>1</sup> See § 266.104(f). That provision was intended to allow furnaces that could not comply with the 20 ppmv HC limit because of organic matter in raw materials to comply with an alternative, higher HC limit. EPA's rationale for the 20 ppmv limit was to ensure good hazardous waste combustion conditions and, thus, control of emissions of products of incomplete combustion (PICs). However, because hydrocarbon emissions from organic matter in raw materials are not directly related to fuel-generated hydrocarbons (i.e., from burning normal fuels and hazardous waste fuels), the Agency believed that these hydrocarbon should not be counted toward the 20 ppmv HC limit. See 56 FR 7155-56. To implement the alternative HC limit, the final rule required such furnaces to establish an HC limit that would be applicable when burning hazardous waste as the HC level achieved when not burning hazardous waste and when the furnace is operated to "minimize" HC levels. See § 266.104(f)(1).

CKRC has noted that this provision could be read to limit fuel-generated hydrocarbons to approximately 2 to 5 ppmv—the HC levels that are achieved when cement kilns (and boilers, incinerators, and other industrial furnaces) are operated under conditions to absolutely minimize HC levels. Therefore, although the Agency limits combustion-generated hydrocarbons from other combustion devices to 20 ppmv, the rule could be read to limit fuel-related hydrocarbon levels from cement kilns to 2 to 5 ppmv. In particular, CKRC notes that the rule

<sup>1</sup> See the BIF docket for documentation of meetings and phone conversations and copies of correspondence.

could be interpreted to limit hydrocarbons when burning hazardous waste to the levels achieved when not burning hazardous waste (i.e., baseline conditions) and when kiln is operated to absolutely minimize HC levels and would not allow the facility to account for normal transient combustion conditions that occur because of factors such as mechanically handling coal. These conditions are elements of normal operating variability. Although these transient conditions cause combustion perturbations and momentary increases (i.e., spikes) in HC levels, these combustion-related HC levels do not generally exceed the 20 ppmv hourly rolling average limit that the Agency has established to control PICs.

Nonetheless, the most literal-minded reading of the rule would preclude consideration of these normal combustion perturbations if the rule's requirement that baseline HC levels be established when the kiln is operated to minimize HC levels is read to mean to operate constantly at absolute peak performance.<sup>2</sup> This literal-minded reading would lead to the result—not intended by EPA—that whenever such a normal combustion perturbation would occur (when the kiln is burning hazardous waste) and there is a spike in the HC level that causes the baseline HC level to be exceeded, the kiln would be required to stop burning hazardous waste and not restart the hazardous waste feed until the HC level falls below the baseline limit. Nor did EPA intend that industrial furnaces operate at an absolutely optimized performance in establishing a baseline ignoring normal operating variability (i.e., a performance level analogous to a New Source Performance Standard rather than best available technology). Indeed, the rule refers to establishing a baseline when the industrial furnace "produces normal products under normal operating conditions" (see § 266.104(f)(1)), and the analogous 20 ppmv HC limit itself is an "indicator of good combustion

<sup>2</sup> Even if the rule were interpreted to allow normal combustion perturbations (i.e., perturbations that do not result in combustion-generated hydrocarbons exceeding 20 ppmv on an hourly rolling average, and thus, are within the Agency's definition of good combustion conditions) during baseline testing, establishing a baseline that includes such normal perturbations would be problematic. This is because the owner or operator cannot ensure that the perturbations that occur during the baseline testing are representative (i.e., in frequency, magnitude, and duration) of normal perturbations. The occurrence of normal perturbations cannot always be predicted, and it would be difficult for the owner or operator to demonstrate that perturbations that could be artificially induced during baseline testing are representative of normal perturbations.

conditions" (see 55 FR 7155), not absolutely optimized combustion.

Although EPA believes these readings take an unduly stringent view of the requirement that HC levels be minimized when establishing a baseline, we nevertheless think it best to clarify the text of the rule. Therefore, EPA is correcting the definition of the baseline HC level provided by § 266.104(f)(1) to make it clear that the measured baseline HC level must be adjusted as appropriate to consider the normal variability of hydrocarbon levels under good combustion operating conditions. Thus, the measured baseline level could be increased by a variability factor that considers normal transient combustion conditions (i.e., provided that the transient conditions do not result in combustion-generated HC that exceed the 20 ppmv limit provided by § 266.104(c)). Accordingly, today's clarification amends the definition of the baseline HC level in § 266.104(f)(1) to read as follows: "The baseline HC level is defined as the average over all valid test runs of the highest hourly rolling average value for each run, adjusted as appropriate to consider the variability of hydrocarbon levels under good combustion operating conditions."

This HC variability factor would be determined on a case-by-case basis by the Director. As guidance in determining what variability factor to apply, EPA believes that a factor of 10 ppmv would be appropriate in most situations.<sup>3</sup> As indicated previously, the Agency believes that combustion-generated HC levels from cement kilns (and other furnaces eligible for the alternative HC limit) should be limited to 20 ppmv to ensure good combustion conditions. This is the same HC limit that applies to boilers, other furnaces, and incinerators, and provides a "level playing field" with respect to control of combustion-generated hydrocarbons. Thus, we recommend that the alternative HC limit be established as 20 ppmv plus the raw material-generated HC level. We do not believe that it is feasible, however, to measure only raw material-generated hydrocarbons; the HC monitor in the stack measures both hazardous waste combustion-generated and raw material-generated hydrocarbons. Therefore, to estimate the level of raw material-generated hydrocarbons, it is

<sup>3</sup> We note that, if a variability of 10 ppmv is used to adjust the measured baseline HC level, facilities with measured HC levels of 11 ppmv or greater would be eligible for the alternative HC limit. This is because the baseline HC level, when adjusted for the 10 ppmv variability factor, would be 21 ppmv or more and facilities with baseline HC levels exceeding 20 ppmv are eligible for the alternative HC limit.

conservative and reasonable to assume that 10 ppmv<sup>4</sup> of the HC measured under baseline conditions (when the kiln must be operated to minimize combustion-generated hydrocarbons) is attributable to hazardous waste combustion. (Note that when the kiln is operated to absolutely minimize hazardous waste combustion-generated hydrocarbons, HC levels should be in the range of 2 to 5 ppmv. Thus, the recommended assumption that combustion-generated hydrocarbons are 10 ppmv during baseline testing is conservative.<sup>5</sup> Under this approach, raw material-generated hydrocarbons are estimated to be the measured HC level during baseline testing minus 10 ppmv. The 20 ppmv combustion-generated HC allowance would then be added to the estimated raw material-generated hydrocarbons. The net effect would be simply to add 10 ppmv to the measured baseline HC level.

As discussed above, the rationale for adding a variability factor to the measured baseline HC level assumes that the baseline level is determined when the device is operated under conditions that generally minimize combustion-generated hydrocarbon.<sup>6</sup> Therefore, combustion-generated hydrocarbon spikes causing a significant increase in the hourly rolling average HC level should not be allowed during baseline testing. To ensure that substantial variability is not already included in the baseline HC level, the hourly rolling average hydrocarbon level should not vary during baseline testing by more than 5 ppmv when measured HC levels are in the range of 10-30 ppmv. When measured HC levels exceed 30 ppmv, then a higher allowable range of HC levels (i.e., the difference

<sup>4</sup> Note that the assumption that 10 ppmv of HC during baseline testing is attributable to hazardous waste combustion is not the basis for the recommended 10 ppmv variability factor. As discussed in the text, however, this assumption leads to the Agency's conclusion that a 10 ppmv variability factor is appropriate.

<sup>5</sup> The assumption that combustion-generated HC is 10 ppmv during baseline testing is conservative because if, for example, we assumed that combustion-generated HC is 5 ppmv, the variability factor would be 15 ppmv, not 10 ppmv. This is because, the lower that the combustion-generated HC is assumed to be, the higher the raw material-generated HC is estimated to be, and the 20 ppmv allowance for combustion-generated HC is added to the estimated raw material-generated HC.

<sup>6</sup> Although it is not practicable for an industrial furnace to operate continuously under conditions that minimize combustion-generated HC as discussed previously in the text, it is reasonable and necessary to require the facility to operate during baseline testing under conditions that generally minimize combustion-generated HC. This is because, otherwise, a variability factor would be added to a baseline HC level that may already include substantial variability.

between the highest and lowest hourly rolling average level) during baseline testing may be appropriate given that the absolute HC levels are higher and even minor perturbations could cause significant changes in HC levels.<sup>7</sup>

EPA is interested in obtaining further information on whether this recommended approach is reasonable to establish an alternative HC limit for devices that cannot meet the 20 ppmv HC limit because of organic matter in raw materials. EPA therefore invites all interested persons to submit any relevant information on this issue.

*2. Industrial Furnaces Complying With the Alternative HC Limit May Comply With the Interim HC Limit Using a Conditioned Gas HC Monitoring System if They Demonstrate That a Heated System Is Impracticable*

Section 266.103(c)(5) of the rule allows owners and operators of BIFs, other than those that obtain a time extension, to certify compliance with the 20 ppmv HC limit using a conditioned gas (i.e., cold) HC monitoring system rather than a heated monitoring system. Although the Agency prefers the heated system because a cold system may remove some hydrocarbons during gas conditioning (e.g., chilling the gas sample line to condense water vapor can also remove hydrocarbons), the Agency recognized that heated systems are not in widespread use on BIFs and modifications to the monitoring systems may be necessary to address operation and maintenance problems. See 56 FR 7162 (February, 21, 1991). Consequently, the Agency reasoned that facilities that comply with the HC limit on Aug. 21, 1992, should be allowed to use a cold system. On the other hand, the Agency reasoned that those owners and operators who obtain a time extension should be required to certify compliance with a hot system given that the time extension should provide enough time to resolve operation and maintenance problems. (Note that facilities that elect to certify compliance with a cold system on Aug. 21, 1992, must use a hot system when they recertify compliance under interim status or obtain a RCRA operating permit. See § 266.103(c)(5).

The Agency did not anticipate the consequences that this requirement would have on cement kilns complying with the alternative hydrocarbon provision of §§ 266.104(f) and 266.103(c)(7)(ii)(B). Under those requirements, cement kilns must, prior to August 21, 1992, submit a complete

Part B permit application that includes documentation of the baseline HC level, and obtain a time extension from the Director. Until the operating permit is issued, the facility must comply with an interim HC (and CO) limit effective no later than August 21, 1992, that is established as a condition of the time extension.

Consequently, although cement kilns complying with the alternative hydrocarbon provision must obtain a time extension, they must monitor hydrocarbons prior to August 21, 1992, in order to establish the baseline HC level, and must monitor hydrocarbons continuously beginning August 21, 1992. Thus, § 266.103(c)(5) has the unintended consequence of requiring such facilities to use a hot HC monitoring system on (and before) August 21, 1992.

As discussed above, the Agency has already determined that this is infeasible (and therefore provided a conditioned (i.e., cold) monitoring option). Therefore, to give such facilities the time they may need to resolve operating and maintenance problems with hot monitoring systems, today's technical correction revises § 266.103(c)(5) to enable the Director to approve on a case-by-case basis the use of a cold system for establishing the baseline HC level and complying with the alternative, interim HC limit. This correction is a logical and necessary adjunct to the existing regulation that allows the alternative use of cold HC monitoring systems. The Director's approval will be based on a demonstration by the facility that it has made a good faith effort to install and operate a heated system but that it has determined that continuous operation is not practicable at this time. The Agency does not believe that this demonstration will be a burden on owners and operators because they have known since February 21, 1991, that a hot monitoring system was required by the rule and should have been attempting to operate continuously such systems for some time.

In considering a request to use a conditioned gas monitor in lieu of a hot monitor, the Director may impose additional requirements on the owner and operator of the facility to ensure that a hot monitoring system is installed as soon as practicable. See § 266.103(c)(7)(ii)(A). For example, the Director may require the owner or operator to operate a hot monitoring system to the extent practicable concurrently with a conditioned gas monitoring system in order to meet specified milestones in activities designed to resolve operational

problems with a heated HC monitoring system, and to report periodically on progress toward achieving sustained operation of the hot monitoring system.

This amendment does not extend the deadline for certification of compliance. Owners and operators requesting to comply with the alternative hydrocarbon limit are required to submit their request along with accompanying supporting materials in time to allow the Director to grant or deny the request by August 21, 1992.

*3. Industrial Furnaces That Cannot Comply With the 20 PPMV HC Limit by August 21, 1992, Because of Organic Matter in Raw Materials May Apply for a Case-by-Case Time Extension To Make Physical Changes to the Facility in Order to Comply With That HC Limit*

The Agency is clarifying the rule to make it clear that industrial furnaces that cannot comply with the 20 ppmv HC limit for reasons beyond the owner's or operator's control may request a time extension to certify compliance with the HC limit. The final rule allows facilities that elected to comply with the alternative hydrocarbon provisions of § 266.104(f) to obtain a time extension under § 266.103(c)(7)(ii)(B). However, the Agency inadvertently did not make it clear that owners and operators that elected to make physical changes to the facility to enable them to comply with the 20 ppmv HC limit (i.e., the usual HC limit, rather than an alternative limit established on a case-by-case basis) but who cannot do so by August 21, 1992, for reasons beyond their control are also eligible to request a time extension under § 266.103(c)(7)(ii).

EPA meant for § 266.103(c)(7)(ii)(B) to apply only to facilities that comply with the alternative HC limit, and believes that this intent is fairly clear in the existing regulatory language since the provision (§ 266.103(c)(7)(ii)(B)(2)) references the procedure for establishing CO and HC baseline levels (§ 266.104(f)(1)) applicable only to persons complying with the alternative HC limit. Conversely, the provisions make little sense for persons who intend to comply with the limit of 20 ppmv because the requirements in § 266.103(c)(7)(ii)(B) are related only to the alternative HC limit.

Accordingly, today's amendment revises § 266.103(c)(7)(ii)(B) to clarify that paragraph applies only to facilities that comply with the alternative HC limit. Thus, the general time extension provision of § 266.103(c)(7)(ii) applies to all other situations, including industrial furnaces that need time to modify the

<sup>7</sup> Baseline testing should consist of a minimum of three test runs, with each run having a minimum duration of three hours.

facility to comply with the 20 ppmv HC limit.

Industrial furnaces such as cement kilns may elect to make physical modifications to the facility to enable them to certify compliance with the 20 ppmv HC limit rather than to comply with the alternative HC provisions of § 266.104(f). If those modifications cannot be completed in time to enable the facility to certify compliance by August 21, 1992, for reasons beyond the facility's control, the owner or operator may request a time extension.

If a time extension is granted, the Director will use the authority of § 266.103(c)(7)(ii) to establish operating conditions as necessary to reasonably ensure that emissions of toxic organic compounds do not pose a threat to human health and the environment. Operating conditions that may be applied may include limits on the type, quantity, and method of firing hazardous waste, and limits on combustion parameters such as oxygen, carbon monoxide, and hydrocarbons.

Examples of physical changes that may be made to the facility in order to meet the 20 ppmv HC limit are: (1) Installation of a secondary combustion chamber to destroy organic compounds in the kiln off-gas; or (2) installation of a roaster to volatilize organic compounds from the raw material before feeding it to the kiln where hazardous waste is burned. These changes may enable the owner or operator to demonstrate that stack gas concentrations do not exceed the 20 ppmv limit. At this time, the Agency has not evaluated the practicability of installing a secondary combustion chamber or roaster to reduce HC emissions. The Agency is simply identifying these as conceivable changes that may enable a facility to meet the 20 ppmv HC limit.

#### *4. The Metals and Total Chlorine and Chloride Feed Rate Operating Limits for Tier I or Adjusted Tier I Are Based on the Screening Limits, Not the Compliance Test*

The final rule requires facilities that comply with the Tier I or Adjusted Tier I feed rate screening limits for metals and total chlorine and chloride to establish feed rate limits based on the feed rates used during the compliance test, and to establish feed rate limits on both pumpable and total hazardous waste feeds. In addition, the final rule requires the owner or operator to conduct a compliance test to document compliance with the particulate matter (PM) limit even though a facility may comply with the Tier I or Adjusted Tier I feed rate screening limits for metals and total chlorine and chloride.

As discussed in the preamble to the final rule (56 FR 7175 (February 21, 1991)), the Tier I or Adjusted Tier I feed rate screening limits are protective of human health and the environment because the limits are back-calculated from acceptable ambient levels using conservative dispersion scenarios, and because the limits are based on an assumption that all metals and chlorine feed to the BIF are emitted (i.e., metals and chlorine do not partition to ash or product and are not removed by an air pollution control system). Because of this, the Agency did not intend for facilities complying with Tier I or Adjusted Tier I to establish feed rate limits on metals or chlorine during a compliance test; rather, the feed rate limits on metals and chlorine are established by the reference tables in appendices I and II of part 266. Further, given that the Tier I or Adjusted Tier I compliance approaches assume that all metals or chlorine fed to the BIF are emitted, it is not necessary to establish a separate feed rate limit for these parameters on pumpable or total hazardous waste. The feed rate limits under Tier I or Adjusted Tier I are based on the total feed rate in total feed streams, and are limited to the levels established in appendices I and II of part 266. (Note, however, that in order to ensure and document compliance with the feed rate screening limits, the facility must nonetheless know the feed rate of metal or chlorine in each feed stream at all times.)

In addition, the Agency considered whether facilities complying with the Tier I or Adjusted Tier I limits for metals and total chlorine and chloride during the compliance test should be required to feed metals and chlorine at the maximum rate during the PM emissions test to ensure maximum PM emissions. As discussed in the preamble to the final rule (56 FR 7144), the Agency is not regulating PM emissions under RCRA *per se*, but rather as a secondary control on emissions of metals and organics that could be adsorbed on the PM. Given that the Tier I or Adjusted Tier I metals and chlorine feed rate screening limits ensure protection of human health and the environment, the Agency does not believe that it is necessary to spike metals and chlorine at the screening feed rate limits during the PM compliance test.

To make sure that these requirements are fully understood the Agency is amending §§ 266.103(c)(1), 266.103(c)(1)(ii)(A), and 266.103(c)(1)(iii) to clarify that the Tier I or Adjusted Tier I feed rate limits are based on the feed rate screening limits specified under §§ 266.106 (b) or (e) (for metals) and

266.107 (b)(1) or (e) (for chlorine) and are not based on the actual feed rates demonstrated during the compliance test. Further, the Agency is clarifying §§ 266.103(b)(3)(ii)(B) and 266.103(c)(1)(ii)(C) by deleting the requirements for metals feed rate limits in total hazardous waste feed and in total pumpable hazardous waste feed when the BIF complies with the Tier I or Adjusted Tier I metals feed rate screening limits.

#### *5. Adjusted Tier I Feed Rate Screening Limits May Be Used in Dispersion Situations Where the Tier I and Tier II Screening Limits Are Precluded*

Sections 266.106(b)(7) and 266.107(b)(3) of the rule preclude the use of the Tier I and Tier II Screening Limits for facilities located in areas where the dispersion characteristics would be worse than were used to calculate the screening limits. Facilities in such situations must conduct dispersion modeling to ensure that the ambient concentrations will not exceed allowable levels. In drafting the final rule, the Agency inadvertently precluded the use of Adjusted Tier I when dispersion characteristics precluded the use of the Tier I and Tier II Screening Limits. Therefore, the Agency is clarifying those paragraphs to allow facilities to apply either the Tier III or Adjusted Tier I feed rate screening limits to control metals and HC1/Cl<sub>2</sub> emissions.

As explained in the final rule, the Agency established the Tier I and Tier II Screening Limits using dispersion modeling; such modeling included a number of conservative assumptions. Despite the conservatism, several situations still existed whereby the Tier I or Tier II limits could result in exposure levels that exceed those established as acceptable in the rule. These specific situations are listed in § 266.106(b)(7). In these situations, facilities are required to conduct dispersion modeling to ensure that metals (or HC1/Cl<sub>2</sub>) concentrations will not exceed allowable levels. Such dispersion modeling is required under both Tier III and Adjusted Tier I standards. However, the Agency inadvertently specified that facilities must comply with Tier III limits when the facility is located in one of the specified nonconservative dispersion situations. Because the same dispersion modeling is required for the Adjusted Tier I standards as for the Tier III standards, this correction makes it clear that facilities may comply with either Adjusted Tier I or Tier III in these situations.

**6. Several Requirements Are Clarified to Account for Facilities That Comply With Adjusted Tier I Limits**

When prescribing requirements for certification of precompliance in § 266.103(b), the Agency did not make it clear that the requirements in paragraphs (b)(2) (ii) and (iii) that apply to facilities that choose to comply with the Tier I controls also apply to facilities that elect to comply with the Adjusted Tier I controls for metals or total chlorine and chloride, although EPA believes this result is implicit since there is no logical reason for the requirements to apply in one case but not the other. Accordingly, today's amendments simply clarify that these provisions also are applicable to facilities that comply with Adjusted Tier I controls.

Similarly, the Agency inadvertently did not require in § 266.106(d) that facilities complying with the Adjusted Tier I controls on metals emissions to also comply with most of the requirements applicable to facilities that comply with Tier III controls, although the February 21, 1991, preamble clearly indicates that these requirements do apply. See 56 FR 7175. Accordingly, the Agency is also clarifying paragraph (d) to add an introductory sentence and revise paragraphs (d) (1) and (5) to apply the appropriate requirements to facilities complying with the Adjusted Tier I controls.

**7. BIF Storage Units Are Subject to the Air Emissions Standards of Subparts AA and BB of Parts 264 and 265**

The final rule subjects storage units for hazardous waste burned in BIFs to the requirements of subparts A through L of parts 264 and 265. See § 266.101(c)(1). The Agency inadvertently omitted reference to subparts AA and BB of parts 264 and 265 that establish air emission standards for process vents and equipment leaks, respectively. Given that these air emissions standards apply to other hazardous waste storage units and are necessary to protect human health and the environment, they apply to storage units for hazardous waste burned in BIFs as well.

To implement this amendment, we are revising § 266.101(c)(1) to require compliance with the requirements of parts 264 and 265 that are applicable to storage units. This approach is preferable to adding a reference specifically to subparts AA and BB because the Agency may add over time other subparts that are applicable to storage units.

In addition, we are amending § 266.101(c)(2) for the same reasons.

That paragraph conditionally exempts storage units for exempt small quantity burners from applicable regulations under parts 264, 265, and 270.

**8. The Definitions of Plasma Arc and Infrared Incinerators Are Clarified To Include Only Those Devices That Use an Afterburner**

In the February 21, 1991 final BIF rule, EPA modified the definition of incinerator in § 260.10 to explicitly include plasma arc and infrared devices as incinerators. See 56 FR 7206. The Agency added the devices to the incinerator definition to make it clear that they were to be regulated as incinerators because: "(1) Although these devices use nonflame sources of thermal energy to treat waste in the primary chamber, they invariably employ controlled flame afterburners to combust hydrocarbons \* \* \*" (emphasis added); and "(2) the incinerator standards are workable and protective for these units."

Since promulgation of the final rule, a number of questions have been raised as to whether the Agency intended to classify as incinerators those plasma arc units that treat the off-gas by methods (e.g., condensation, catalytic converters) other than by combustion in a controlled flame afterburner.<sup>8</sup> As indicated above, the Agency made this modification based on the (incorrect) understanding that these units invariably use controlled flame combustion in the afterburner. Given that there are plasma arc or infrared units that do not use controlled flame combustion in an afterburner or other device—that is, they do not meet the definition of incinerator (i.e., before the Agency amended the definition to include plasma arc and infrared units)—and the incinerator regulations are not appropriate for devices not employing combustion, the Agency is today clarifying the definitions of these units to specifically refer to the use of such an afterburner (as stated in the February 21, 1991, preamble).

Plasma arc and infrared devices that are not incinerators because they do not use controlled flame combustion in an afterburner are subject to regulation under subpart P, part 265 (for units in interim status) and subpart X, part 264

<sup>8</sup> See the memorandum from Sylvia Lowrance, Director, Office of Solid Waste, EPA, to Allyn M. Davis, Director, Region VI Hazardous Waste Management Division dated September 30, 1991, stating that the BIF rule unintentionally includes as incinerators plasma arc and infrared units not equipped with an afterburner, and that the Agency intends to issue a technical correction to the incinerator definition to address the error.

(for units operating under a RCRA permit).

Finally, we note that the revisions to these definitions (being non-HSWA) do not take effect in an authorized state until the state becomes authorized for the rule change.

**9. Facilities That Comply With the Tier I or Adjusted Tier I Metals and Chlorine Controls and That Have Uncontrolled Emissions That Meet the Particulate Matter Standard Need Not Establish a Limit on Production Rate During Interim Status**

Sections 266.103(b)(3)(v) and 266.103(c)(vi) of the rule require BIFs to establish an operating limit during interim status on maximum production rate when producing normal product. The Agency required a limit on maximum production rate as a surrogate for gas flow rate through the air pollution control system (APCS) to ensure that the collection efficiency of the system would not be compromised at higher gas flow rates—and higher production rates—than occurred during the compliance test. In drafting the final rule, the Agency inadvertently required that a limit on maximum production rate be established during interim status in a situation where a limit is not needed—when an APCS is not needed to comply with the emissions standards for metals, HCl, Cl<sub>2</sub>, or particulate matter (PM).

Consequently, EPA is correcting the rule to indicate that the requirement to establish a maximum production rate during interim status is not necessary when: (1) The BIF complies with Tier I or Adjusted Tier I feed rate limits for all metals and total chlorine and chloride (which are conservatively based on a reasonable, worst-case dispersion scenario and assume that all metals and chlorine fed to the BIF are emitted (i.e., no partitioning to bottom ash or product and no removal by an APCS)); and (2) uncontrolled stack emissions comply with the PM standard (i.e., when there is no APCS or when emissions at the inlet to an APCS meet the PM standard).

**10. Halogen Acid Furnaces That Burn Hazardous Waste as an Ingredient Are Subject to the BIF Rule**

In the BIF rule published on Feb. 21, 1991, the Agency amended § 261.2(d) to list as inherently waste-like any secondary material that is identified or listed as a hazardous waste and that is fed to a halogen acid furnace (HAF). See 56 FR 7141 for the reasons for this rule. By doing this, the Agency made clear that burning of secondary materials in HAFs that exhibit a characteristic or are specifically listed would subject those

units to the BIF regulations. While the Agency revised § 261.2(d) by adding paragraph (d)(2), the Agency inadvertently did not make a conforming change to § 261.2(e)(2)(iv) that identifies materials that are solid wastes, even if the recycling involves use, reuse, or return to the original process. Accordingly, the Agency is today revising § 261.2(e)(2)(iv) to include a reference to paragraph (d)(2) to make it clear that inherently waste-like materials burned in a HAF are solid (and hazardous) wastes even if such burning is recycling by use, reuse, or return to the original process.

*11. When Comparing Levels of Nonmetal Constituents in Residue to the Health-Based Limits for the Bevill Exclusion, the Levels Cannot Exceed the Health-Based Limits or the Level of Detection, Whichever Is Higher*

Section 266.112 of the BIF rule prescribes requirements for determining whether residues from certain devices retain the Bevill exclusion. See 56 FR 7196-7200 (Feb. 21, 1991). Paragraph (b)(2)(i) of that section provides for a comparison of nonmetal constituents in the waste-derived residue to health-based limits established in the rule (see appendix VII, part 266) in determining whether the residue would retain the Bevill exclusion. This paragraph also indicates that if a health-based limit for a constituent was not included in appendix VII, then a default limit of 0.002 micrograms per kilogram or the level of detection, whichever is higher must be used. A number of questions have been raised to the Agency as to how an owner or operator is to make this determination if a health-based level is identified in appendix VII but the analytical detection level for that constituent(s) exceeds the health-based level.

As indicated above, the Agency addressed this issue for those constituents for which a health-based limit was not identified in appendix VII, part 266 (i.e., those constituents subject to the default limit of 0.002 micrograms per kilogram). In these circumstances, the owner or operator had to meet either a level of 0.002 micrograms per kilogram or the level of detection, whichever is higher. The Agency took this approach because of concern that the level of analytical detection for nonmetal constituents in kiln dust may be higher than the default limit of 0.002 micrograms per kilogram. In these situations, the owner or operator could not document compliance with the 0.002 micrograms per kilogram limit even when using the SW-846 analytical

procedure providing the lowest level of detection.

For the same reason, the Agency also intended to cap the health-based limit by the level of detection for a constituent(s) for which a health-based limit (i.e., other than the default limit) is established in appendix VII, part 266. However, the rule inadvertently does not include that language. To clarify this provision, we are today modifying the rule to require that, for purposes of complying with paragraph (b)(2)(i), the concentration of each nonmetal constituent in the waste-derived residue cannot exceed the health-based limit established in appendix VII, part 266, or the level of detection, whichever is higher.

*12. The Applicability of Part 266 Is Clarified*

In the Technical Amendments to the final BIF rule published at 56 FR 42513 (Aug. 27, 1991), EPA amended § 266.100 (Applicability) to add paragraph (f) that exempted precious metal recovery furnaces from the BIF rule. The Agency also made a conforming revision to paragraph (a) of that section to add "and (f)" in the first sentence. The Agency subsequently made other changes to § 266.100 and published those changes at 56 FR 43877 (Sept. 5, 1991). In the September 5 notice, the Agency inadvertently neglected to include the earlier amendment by which "and (f)" was added to the first sentence of § 266.100. To correct this omission, we are reissuing in today's notice the amendment to paragraph (a) made on August 27.

*13. Conforming Revisions are Made to the Applicability Sections of Parts 264 and 265*

The BIF rule, which is codified as subpart H, part 266, replaced regulations for burning hazardous waste for energy recovery that were codified in subpart D, part 266. When the BIF rule was promulgated, the Agency inadvertently did not make conforming revisions to the applicability sections of parts 264 and 265. Consequently, the Agency is today revising §§ 264.1(g)(2) and 265.1(c)(6) (which exempt facilities managing recyclable materials except to the extent that requirements in those parts are referred to in subparts to part 266) to delete reference to (now reserved) subpart D, part 266, and to reference subpart H, part 266.

*14. A Conforming Revision Is Made to the Rulemaking Petitions Provision of Part 260*

When part 266 was established, the Agency inadvertently did not make a

conforming revision to § 260.20(a) to allow rulemaking petitions to be submitted to the Administrator to modify or revoke any provisions of part 266. Section 260.20(a) already allows rulemaking petitions to parts 260 through 265 and 268. Accordingly, § 260.20(a) is amended today to also refer to part 266.

**B. Technical Corrections**

On July 17, 1992, and August 27, 1991, EPA published several technical corrections and amendments to the February 21 final rule (see 56 FR 32668 and 42504). Today's notice corrects several errors published in those notices.

**C. Immediate Effective Date**

EPA has determined to make today's action effective immediately. The Agency believes that the corrections being made in this notice are either interpretations of existing regulations which do not require prior notice and opportunity for comment (corrections 1, 3, and 11), or are technical corrections of obvious errors in the rule (for example, corrections of regulatory language that is inconsistent with the preamble or with otherwise clearly indicated Agency intent) for which comment is unnecessary (within the meaning of 5 U.S.C. 553(b)(3)(B)) (the remaining corrections).

**List of Subjects**

*40 CFR Part 260*

Administrative practice and procedure, Confidential business information, Hazardous waste.

*40 CFR Part 261*

Hazardous waste, Recycling, Reporting and recordkeeping requirements.

*40 CFR Part 264*

Air pollution control, Hazardous waste, Insurance, Packaging and containers, Reporting and recordkeeping requirements, Security measures, Surety bonds.

*40 CFR Part 265*

Air pollution control, Hazardous waste, Insurance, Packaging and containers, Reporting and recordkeeping requirements, Security measures, Surety bonds, Water supply.

*40 CFR Part 266*

Energy, Hazardous waste, Petroleum, Recycling, Reporting and recordkeeping requirements.

Dated: August 11, 1992.

Don R. Clay,  
Assistant Administrator for Solid Waste and  
Emergency Response.

For the reasons set out in the  
preamble, 40 CFR parts 260, 261, 264,  
265, and 266 are amended as follows:

**PART 260—HAZARDOUS WASTE  
MANAGEMENT SYSTEM: GENERAL**

I. In part 260:

1. The authority citation for part 260  
continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6921-  
6927, 6930, 6934, 6935, 6937, 6938, 6939, and  
6974.

2. In § 260.10, the definitions for  
"Infrared incinerator" and "Plasma arc  
incinerator" are revised to read as  
follows:

**§ 260.10 Definitions.**

*Infrared incinerator* means any  
enclosed device that uses electric  
powered resistance heaters as a source  
of radiant heat followed by an  
afterburner using controlled flame  
combustion and which is not listed as an  
industrial furnace.

*Plasma arc incinerator* means any  
enclosed device using a high intensity  
electrical discharge or arc as a source of  
heat followed by an afterburner using  
controlled flame combustion and which  
is not listed as an industrial furnace.

3. In § 260.20, the first sentence of  
paragraph (a) is revised to read as  
follows:

**§ 260.20 General.**

(a) Any person may petition the  
Administrator to modify or revoke any  
provision in parts 260 through 266 and  
268 of this chapter. \* \* \*

**PART 261—IDENTIFICATION AND  
LISTING OF HAZARDOUS WASTE**

II. In part 261:

1. The authority citation for part 261  
continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6921,  
6922, and 6938.

2. Section 261.2 is amended by  
revising paragraph (e)(2)(iv) to read as  
follows:

**§ 261.2 Definition of solid waste.**

(e) \* \* \*  
(2) \* \* \*  
(iv) Materials listed in paragraphs  
(d)(1) and (d)(2) of this section.

**PART 264—STANDARDS FOR  
OWNERS AND OPERATORS OF  
HAZARDOUS WASTE TREATMENT,  
STORAGE, AND DISPOSAL  
FACILITIES**

III. In part 264:

1. The authority citation for part 264  
continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6924, and  
6925.

2. In § 264.1, paragraph (g)(2) is  
revised to read as follows:

**§ 264.1 Purpose, scope, and applicability.**

(g) \* \* \*  
(1) \* \* \*

(2) The owner or operator of a facility  
managing recyclable materials  
described in § 261.6(a) (2) and (3) of this  
chapter (except to the extent that  
requirements of this part are referred to  
in subparts C, F, G, or H of part 266 of  
this chapter).

**PART 265—INTERIM STATUS  
STANDARDS FOR OWNERS AND  
OPERATORS OF HAZARDOUS WASTE  
TREATMENT, STORAGE, AND  
DISPOSAL FACILITIES**

IV. In part 265:

1. The authority citation for part 265  
continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6924,  
6925, and 6935.

2. In § 265.1, paragraph (c)(6) is  
revised to read as follows:

**§ 265.1 Purpose, scope, and applicability.**

(c) \* \* \*

(6) The owner and operator of a  
facility managing recyclable materials  
described in § 261.6(a) (2) and (3) of this  
chapter (except to the extent that  
requirements of this part are referred to  
in subparts C, F, G, or H of part 266 of  
this chapter).

**PART 266—STANDARDS FOR THE  
MANAGEMENT OF SPECIFIC  
HAZARDOUS WASTES AND SPECIFIC  
TYPES OF HAZARDOUS WASTE  
MANAGEMENT FACILITIES**

V. In part 266:

1. The authority citation for part 266  
continues to read as follows:

Authority: Secs. 1006, 2002(a), 3004, and  
3014 of the Solid Waste Disposal Act, as  
amended by the Resource Conservation and  
Recovery Act of 1976, as amended (42 U.S.C.  
6905, 6912(a), 6924, and 6934).

2. In § 266.100, paragraph (a) is  
amended by revising the first sentence

to read as follows, and paragraph (f)  
introductory text is amended by  
revising, "§ 261.111" to read "§ 266.111".

**§ 266.100 Applicability.**

(a) The regulations of this subpart  
apply to hazardous waste burned or  
processed in a boiler or industrial  
furnace (as defined in § 260.10 of this  
chapter) irrespective of the purpose of  
burning or processing, except as  
provided by paragraphs (b), (c), (d), and  
(f) of this section. \* \* \*

3. In § 266.101, the first sentence of  
paragraph (c)(1), and paragraph (c)(2)  
are revised to read as follows:

**§ 266.101 Management prior to burning.**

(c) *Storage Facilities.* (1) Owners and  
operators of facilities that store  
hazardous waste that is burned in a  
boiler or industrial furnace are subject  
to the applicable provisions of parts 264,  
265, and 270 of this chapter, except as  
provided by paragraph (c)(2) of this  
section. \* \* \*

(2) Owners and operators of facilities  
that burn, in an onsite boiler or  
industrial furnace exempt from  
regulation under the small quantity  
burner provisions of § 266.108,  
hazardous waste that they generate are  
exempt from the regulations of parts 264,  
265, and 270 of this chapter applicable to  
storage units for those storage units that  
store mixtures of hazardous waste and  
the primary fuel to the boiler or  
industrial furnace in tanks that feed the  
fuel mixture directly to the burner.  
Storage of hazardous waste prior to  
mixing with the primary fuel is subject  
to regulation as prescribed in paragraph  
(c)(1) of this section.

4. Section 266.103 is amended by  
revising paragraphs (b)(2)(ii)  
introductory text and (iii), (b)(3)(ii)(B),  
(b)(3)(v), (c)(1) introductory text,  
(c)(1)(ii) (A) and (C), (c)(1)(iii), (c)(1)(vi),  
(c)(5), and (c)(7)(ii)(B) to read as follows:

**§ 266.103 Interim status standards for  
burners.**

(b) \* \* \*  
(2) \* \* \*

(ii) Except for facilities complying  
with the Tier I or Adjusted Tier I feed  
rate screening limits for metals or total  
chlorine and chloride provided by  
§§ 266.106 (b) or (e) and 266.107 (b)(1) or  
(e), respectively, the estimated  
uncontrolled (at the inlet to the air  
pollution control system) emissions of  
particulate matter, each metal controlled  
by § 266.106, and hydrogen chloride and

chlorine, and the following information to support such determinations:

(iii) For facilities complying with the Tier I or Adjusted Tier I feed rate screening limits for metals or total chlorine and chloride provided by §§ 266.106 (b) or (e) and 266.107 (b)(1) or (e), the feed rate (lb/hr) of total chloride and chlorine, antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, silver, and thallium in each feed stream (hazardous waste, other fuels, industrial furnace feedstocks).

(3) \* \* \*

(ii) \* \* \*  
(B) Total hazardous waste feed, unless complying with the Tier I or Adjusted Tier I metals feed rate screening limits under § 266.106 (b) or (e); and

(v) Maximum production rate of the device in appropriate units when producing normal product, unless complying with the Tier I or Adjusted Tier I feed rate screening limits for chlorine under § 266.107 (b)(1) or (e) and for all metals under § 266.106 (b) or (e), and the uncontrolled particulate emissions do not exceed the standard under § 266.105.

(c) \* \* \*

(1) *Limits on operating conditions.* The owner or operator shall establish limits on the following parameters based on operations during the compliance test (under procedures prescribed in paragraph (c)(4)(iv) of this section) or as otherwise specified and include these limits with the certification of compliance. The boiler or industrial furnace must be operated in accordance with these operating limits and the applicable emissions standards of §§ 266.104 (b) through (e), 266.105, 266.106, 266.107, and 266.103(a)(5)(I)(D) at all times when there is hazardous waste in the unit.

(ii) \* \* \*

(A) Total feedstreams, except that:  
(1) Facilities that comply with Tier I or Adjusted Tier I metals feed rate screening limits may set their operating limits at the metals feed rate screening limits determined under § 266.106 (b) or (e); and

(2) Industrial furnaces that must comply with the alternative metals implementation approach under paragraph (c)(3)(ii) of this section must specify limits on the concentration of each metal in the collected particulate matter in lieu of feed rate limits for total feedstreams;

(B) \* \* \*

(C) Total pumpable hazardous waste feed (unless complying with the Tier I or Adjusted Tier I metals feed rate screening limits under § 266.106 (b) or (e);

(iii) Total feed rate of chlorine and chloride in total feed streams, except that facilities that comply with Tier I or Adjusted Tier I feed rate screening limits may set their operating limits at the total chlorine and chloride feed rate screening limits determined under § 266.107 (b)(1) or (e).

(vi) Maximum production rate of the device in appropriate units when producing normal product, unless complying with the Tier I or Adjusted Tier I feed rate screening limits for chlorine under § 266.107 (b)(1) or (e) and for all metals under § 266.106 (b) or (e), and the uncontrolled particulate emissions do not exceed the standard under § 266.105.

(5) *Special requirements for HC monitoring systems.* When an owner or operator is required to comply with the hydrocarbon (HC) controls provided by § 266.104(c) or paragraph (a)(5)(i)(D) of this section, a conditioned gas monitoring system may be used in conformance with specifications provided in appendix IX of this part provided that the owner or operator submits a certification of compliance without using extensions of time provided by paragraph (c)(7) of this section. However, owners and operators of facilities electing to comply with the alternative hydrocarbon provision of § 266.104(f) and requesting a time extension under § 266.103(c)(7)(ii)(B) may establish the baseline HC level and comply with the interim HC limit established by the time extension using a conditioned gas monitoring system if the Director determines that the owner or operator has demonstrated that they have made a good faith effort to operate a heated monitoring system but found it to be impracticable.

(7) \* \* \*

(ii) \* \* \*

(B) When an owner or operator requests an extension of time to enable the facility to comply with the alternative hydrocarbon provisions of § 266.104(f) and obtain a RCRA operating permit because the facility cannot meet the HC limit of § 266.104(c) of this chapter:

5. Section 266.104 is amended by revising paragraph (f)(1) to read as follows:

§ 266.104 Standards to control organic emissions.

(f) \* \* \*

(1) When the baseline HC (and CO) level is determined, the owner or operator must demonstrate that the facility is designed and operated to minimize hydrocarbon emissions from fuels and raw materials and that the facility is producing normal products under normal operating conditions feeding normal feedstocks and fuels. The baseline HC level is defined as the average over all valid test runs of the highest hourly rolling average HC value for each run when the facility does not burn hazardous waste, adjusted as appropriate to consider the variability of hydrocarbon levels under good combustion operating conditions. The baseline CO level is determined based on the test runs used to establish the baseline HC level and is defined as the average over all test runs of the highest hourly rolling average CO value for each run. More than one baseline level must be determined if the facility operates under different modes that may generate significantly lower HC (and CO) levels;

6. Section 266.106 is amended by revising paragraphs (b)(7) introductory text, (d)(1), (d)(5), and by revising the equation in paragraph (d)(3) to read as follows:

§ 266.106 Standards to control metals emissions.

(b) \* \* \*

(7) *Criteria for facilities not eligible for screening limits.* If any criteria below are met, the Tier I and Tier II screening limits do not apply. Owners and operators of such facilities must comply with either the Tier III standards provided by paragraph (d) of this section or with the adjusted Tier I feed rate screening limits provided by paragraph (e) of this section.

(d) *Tier III and Adjusted Tier I site-specific risk assessment.* The requirements of this paragraph apply to facilities complying with either the Tier III or Adjusted Tier I controls, except where specified otherwise.

(1) *General.* Conformance with the Tier III metals controls must be demonstrated by emissions testing to determine the emission rate for each metal. In addition, conformance with either the Tier III or Adjusted Tier I metals controls must be demonstrated by air dispersion modeling to predict the maximum annual average off-site ground level concentration for each

dispersion modeling to predict the maximum annual average off-site ground level concentration for each metal, and a demonstration that acceptable ambient levels are not exceeded.

(3) \* \* \*

$$\sum_{i=1}^n \frac{\text{Predicted Ambient Concentration}_{(i)}}{\text{Risk-Specific Dose}_{(i)}} < 1.0$$

\* \* \*

(5) *Multiple stacks.* Owners and operators of facilities with more than one on-site stack from a boiler, industrial furnace, incinerator, or other thermal treatment unit subject to controls on metals emissions under a RCRA operating permit or interim status controls must conduct emissions testing (except that facilities complying with Adjusted Tier I controls need not conduct emissions testing) and dispersion modeling to demonstrate that the aggregate emissions from all such on-site stacks do not result in an exceedance of the acceptable ambient levels.

7. Section 266.107 is amended by revising paragraph (a) to read as follows:

**§ 266.107 Standards to control hydrogen chloride (HCl) and chlorine gas (Cl<sub>2</sub>) emissions.**

(a) *General.* The owner or operator must comply with the hydrogen chloride

(HCl) and chlorine (Cl<sub>2</sub>) controls provided by paragraph (b), (c), or (e) of this section.

\* \* \*

8. Section 266.108(c) is amended by revising the equation to read as follows:

**§ 266.108 Small quantity on-site burner exemption.**

\* \* \*

(c) \* \* \*

$$\sum_{i=1}^n \frac{\text{Actual Quantity Burned}_{(i)}}{\text{Allowable Quantity Burned}_{(i)}} < 1.0$$

\* \* \*

9. Section 266.112 is amended by revising paragraph (b)(2)(i) to read as follows:

**§ 266.112 Regulation of residues.**

\* \* \*

(b) \* \* \*  
(2) \* \* \*

(i) *Nonmetal constituents.* The concentration of each nonmetal toxic constituent of concern (specified in paragraph (b)(1) of this section) in the waste-derived residue must not exceed the health-based level specified in appendix VII of this part, or the level of detection (using analytical procedures prescribed in SW-846), whichever is higher. If a health-based limit for a constituent of concern is not listed in

appendix VII of this part, then a limit of 0.002 micrograms per kilogram or the level of detection (using analytical procedures prescribed in SW-846), whichever is higher, shall be used; and

\* \* \*

**Appendix IX [Amended]**

10. In appendix IX, § 5.0, Hazardous Waste Combustion Air Quality Screening Procedure, Table 5.0-3.—Clarification of Land Use Types, footnote 1, revise "EPA-450/2-78-027" to read "EPA-450/2-78-027R".

11. In appendix IX, § 5.0, Hazardous Waste Combustion Air Quality Screening Procedure, in the title to Table 5.0-4, revise "ISCT" to read "ISCST", revise "PREDICATED" to read "PREDICTED", and revise "8G/M<sup>3</sup>" to read "g/m<sup>3</sup>".

12. In appendix IX, § 5.0, Hazardous Waste Combustion Air Quality Screening Procedure, in the title to Table 5.0-5, revise "ISCT" to read "ISCST", revise "PREDICATED" to read "PREDICTED", and revise "8G/M<sup>3</sup>" to read "g/m<sup>3</sup>".

13. In appendix IX, § 6.0—Simplified Land Use Classification Procedure for Compliance with Tier I and Tier II Limits, Subsection 6.1 Introduction: second paragraph, add a footnote "1" after "(EPA 1986)"; in footnote 1, revise "EPA-450/2-78-027" to read "EPA-450/2-78-027R"; and in the third paragraph, revise "Auer 3978" to read "Auer 1978".

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