

The attached guidance, “Presumptive BACT for Formaldehyde Emissions Generated From Landfill Gas-Fired SI RICE”, was developed for use by Department staff when making decisions related to implementing compliance method under s. NR 445.08(2)(f), Wis. Adm. Code to control formaldehyde emissions generated from landfill gas-fired SI RICE, when requested by the permittee for any construction or operation permit, as applicable.

Landfill gas-fired SI RICE are a source of formaldehyde emissions. Many facilities that fire landfill gas in SI RICE operate enough to have emissions above the NR 445 threshold values in Table A and are major sources of federal HAPs regulated under the Clean Air Act Amendments of 1990. Because certain landfill gas-fired SI RICE are not regulated by an *emission standard* under a National Emission Standard for Hazardous Air Pollutants (NESHAP) and they are located at facilities that are unable to achieve compliance through the use of the risk based compliance methods under s. NR 445.08(2) or (3), Wis. Adm. Code, they are required to limit formaldehyde emissions to the control requirement of BACT.

In 2011, the Badger Chapter of the Solid Waste Association of North America and the Wisconsin Counties Solid Waste Association approached the Department to propose the preparation of a presumptive BACT analysis. In response, the Landfill Technical Advisory Committee (TAC) was formed. Over the course of 2 years, the Landfill TAC group met, developed, discussed and reviewed a presumptive BACT analysis for formaldehyde emissions resulting from landfill gas-fired SI RICE. The attached draft guidance is the product of the group.

The Department is soliciting comments from external stakeholders on the draft guidance for 21 days. Once the 21 day notice period is complete, all comments will be considered, revisions will be made to the guidance as needed, and final guidance will be made available to the appropriate internal and external stakeholders.

Comments related to this draft guidance document should be sent to Andrew Stewart, [andrew.stewart@wisconsin.gov](mailto:andrew.stewart@wisconsin.gov); (608) 264-8884.

DATE: TBD

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SUBJECT: Presumptive BACT for Formaldehyde Emissions Generated From Landfill Gas-Fired SI RICE

This presumptive best available control technology (BACT) for formaldehyde emissions generated from landfill gas-fired spark ignition (SI) reciprocating internal combustion engines (RICE) is the result of the efforts of the Landfill Technical Advisory Committee (TAC). The Landfill TAC consisted of representatives from the solid waste industry, consultants, engine manufacturers and Department staff.

This presumptive BACT is available for use as a compliance method under s. NR 445.08(2)(f), Wis. Adm. Code to control formaldehyde emissions generated from landfill gas-fired SI RICE, when requested by the permittee for any construction or operation permit, as applicable. This presumptive BACT is not intended for use as a compliance method to meet control requirements specified in any other chs. NR 400-499, Wis. Adm. Code, including BACT and lowest achievable emission rate (LAER) requirements specified in chs. NR 405 and 408, Wis. Adm. Code, respectively.

## 1. Background

Ch. NR 445, Wis. Adm. Code applies to all sources which emit hazardous air pollutants (HAPs) unless regulated by an *emission standard* promulgated under section 112 of the Clean Air Act or exempt under s. NR 445.07(5), Wis. Adm. Code. Compliance options under ch. NR 445, Wis. Adm. Code, include limiting emissions to below threshold values in Tables A, B, or C, demonstrating the risk from the emission sources is below established levels in s. NR 445.08(2) or (3), Wis. Adm. Code, or meeting the control requirement listed in the Tables.

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Section NR 445.02(1m), Wis. Adm. Code defines BACT as

“an emission limit for a hazardous air pollutant based on the maximum degree of reduction practically achievable taking into account energy, economic and environmental impacts and other costs related to the source.”

A final presumptive BACT analysis was presented to the Department on October 16, 2012. The presumptive BACT analysis is based on the scenario of four 1,600 kilowatt (kW) SI RICE combusting approximately 2,400 standard cubic feet per minute (scfm) of landfill gas. Emission rates are estimated based on the default Department emission factor of 0.3 grams of formaldehyde per brake horsepower-hour for landfill gas-fired SI RICE applications. This analysis is specific to formaldehyde for landfill gas-fired RICE and may not be used as a presumptive BACT for other sources.

The presumptive BACT analysis presented here follows US EPA's "top-down BACT methodology".<sup>1</sup> This five step process involves 1) identifying all available control technologies, 2) eliminating technically infeasible options, 3) ranking the remaining control technologies by control effectiveness, 4) evaluating the most effective controls and documenting results and 5) selecting BACT.

At the time of this writing, it should be noted that while the operational record of these technologies was not included in the top-down BACT analysis, none of these technologies have a proven operational record for controlling formaldehyde emissions generated from landfill gas-fired engines. The technical feasibility for controlling formaldehyde emissions generated from landfill gas-fired engines was evaluated using technologies whose effectiveness has been demonstrated on projects using similar fuels and/or controlling similar pollutants.

## 2. Presumptive BACT Analysis:

**A. Control Technology Options:** The presumptive BACT analysis as submitted to and reviewed by the Department identified technically available control options. Those technologies were considered and evaluated consistent with Steps 1, 2 and 3 of EPA's top-down BACT methodology: The following technologies (ranked in order of effectiveness) were further evaluated consistent with Steps 4 & 5:

- Thermal oxidizer (without preconcentrator)
- Enclosed flare afterburner (without preconcentrator)
- Wet scrubber
- Oxidation catalyst with site-specific engineered siloxane and hydrogen sulfide removal system
- Good combustion practices and manufacturer-specified maintenance

**B. Economic Impact Evaluation:** To provide an evaluation of the economic impacts of the control options listed in 2.A. above, the cost of each add-on control option has been indexed to the amount of formaldehyde removed and to the amount of electricity produced by the RICE. The table below summarizes the total annualized cost for each add-on control technology in dollars per ton of formaldehyde (HCOH) removed, and dollars per kilowatt hour of site operation:

Control Technology	Total Annualized Cost (\$/ton of HCOH)	Total Annualized Cost (\$/kW-hour)
Thermal oxidizer (without preconcentrator)	\$56,200	\$0.030
Enclosed flare afterburner (without preconcentrator)	\$222,000	\$0.118
Wet scrubber	\$56,300	\$0.028
Oxidation catalyst with site-specific engineered siloxane and hydrogen sulfide removal system	\$53,800	\$0.021

To provide context, the cost of add-on controls were compared to other BACT decisions requiring add-on control for reducing formaldehyde emissions. The costs reflect decisions made by the Department across all

<sup>1</sup> New Source Review Workshop Manual (Draft, October 1990), Chapter B, Section III, (<http://www.epa.gov/region07/air/nsr/nsrmemos/1990wman.pdf>).

source categories from 1990 to the present. Historically, the total annualized cost of previous formaldehyde BACT decisions made under ch. NR 445, Wis. Adm. Code ranges between \$4,120 and \$64,919 per ton of formaldehyde removed. The lowest cost add-on control option considered for landfill gas-fired SI RICE of \$53,800 per ton of formaldehyde removed is within the range of past formaldehyde BACT decisions.

C. Evaluation of Other Factors: Landfills of a certain size are required to capture and control the landfill gas resulting from decomposition of waste materials under the New Source Performance Standards for Municipal Solid Waste Landfills (s. NR 440.75, Wis. Adm. Code, and 40 CFR Part 60, Subpart WWW), or the Emission Guidelines for Municipal Solid Waste Landfills (40 CFR Part 60, Subpart Cc). All landfills are equipped with flares as a primary or backup method to control landfill gas. In the last twenty years, large landfills have commonly used SI RICE to combust at least a portion of the landfill gas to generate electricity and recoverable waste heat, offsetting the use of virgin fossil fuels. The electricity generated by SI RICE is often sold to electrical utility companies under a power purchase agreement (PPA). Typical revenues generated under a PPA, and typical operations and maintenance (O&M) costs were considered when evaluating the economic impact of control options.

To support the energy recovery potential of burning landfill gas in RICE, the sum of the total annualized costs for proposed add-on controls, capital investment, and operation & maintenance costs may exceed the gross revenue for a typical landfill gas-fired SI RICE installation, which was taken into consideration in determining BACT.

After considering all factors, the Department has determined that the add-on control technology options listed in 2.A. are not economically feasible for landfill gas-fired SI RICE at this time. Following the US EPA top-down BACT methodology, the next feasible control option is proposed as BACT. *Presumptive BACT for formaldehyde emissions generated from landfill gas-fired SI RICE will be work practice standards, monitoring and record keeping requirements as defined in Section 3.*

### 3. Presumptive BACT

A. Applicability: The following presumptive BACT applies to each landfill gas-fired SI RICE engine that meets the following conditions:

- Landfill gas is at least 10% or more of the gross heat input to the SI RICE on an annual basis;
- The landfill gas-fired SI RICE is not subject to an emission standard promulgated under section 112 of the Clean Air Act; and

The owner or operator of the landfill gas-fired SI RICE is either paid less than a Threshold Energy Price of \$0.08 per kilowatt-hour.

Threshold Energy Price =  $\frac{\text{Total Revenue (\$)}}{\text{Total Energy Produced (kw-hr)}}$  ; or

The owner or operator of the landfill gas-fired SI RICE documents an operating margin of less than \$0.05 per kilowatt-hour, calculated before controls. Operating margin shall be calculated as the difference between the Threshold Energy Price and the ten-year average annualized costs associated with operating the landfill gas-fired RICE (including capital investment, O&M, etc.), calculated in accordance with generally accepted accounting principles.

- For existing landfill gas-fired SI-RICE
  - Total revenue = total revenue received from the energy produced (including renewable credits) during the most recent 24 consecutive months before the permit application is submitted, in dollars.
  - Total energy sold = total energy sold during the most recent 24 consecutive months before the permit application was submitted, in kilowatt-hours.

- For a new landfill gas-fired SI RICE,
  - Total revenue = projected revenue based on the power purchase agreement or equivalent documentation, and total energy produced (see definition below).
  - Total energy produced = maximum amount of energy that the landfill gas-fired SI RICE are capable of producing, in kilowatt-hours based on the maximum theoretical capacity of the SI RICE.

This presumptive BACT is available for use by any facility with landfill gas-fired SI RICE that meets the applicability requirements, at its discretion. Alternatively, any facility with landfill gas-fired SI RICE may elect to submit a site-specific BACT analysis or use any other compliance methods available under ch. NR 445, Wis. Adm. Code.

## B. Requirements:

### 1. Work Practice Standards

- a. Change the oil and filter every 1,440 hours of operation or annually, whichever comes first. The facility may opt to use an oil analysis program to extend this specified oil change interval requirement. The oil analysis program must be performed at the same frequency specified for changing the oil above. The oil analysis program must at a minimum analyze the following three parameters: Total Acid Number, viscosity, and percent water content. The condemning limits for these parameters are as follows: Total Acid Number increases by more than 3.0 milligrams of potassium hydroxide (KOH) per gram from Total Acid Number of the oil when new; viscosity of the oil has changed by more than 20 percent from the viscosity of the oil when new; or percent water content (by volume) is greater than 0.5. If all of these condemning limits are not exceeded, the engine owner or operator is not required to change the oil. If any of the limits are exceeded, the engine owner or operator must change the oil within 2 days of receiving the results of the analysis. If the engine is not in operation when the results of the analysis are received, the engine owner or operator must change the oil within 2 days or before commencing operation, whichever is later.
- b. Inspect spark plugs every 1,440 hours of operation or annually, whichever comes first, and replace as necessary.
- c. Inspect all hoses and belts every 1,440 hours of operation or annually, whichever comes first, and replace as necessary.
- d. If a site-specific engine maintenance plan recommends a different interval than those specified in B.1.a., b. or c., the permittee shall follow whichever interval is more stringent.
- e. Operate and maintain any pre-engine landfill gas treatment or conditioning system according to the manufacturer's emission related written instructions.

### 2. Stack Emission Testing

- a. If stack testing has not been performed within five years of application submittal, the owner or operator shall perform stack emission testing within 90 days of permit issuance. Testing shall be conducted on one of each class or category of engine at the facility to determine an emission factor for formaldehyde. The test report shall report formaldehyde emissions in pounds of formaldehyde emitted per hour, pounds of formaldehyde per MMBTU of landfill gas combusted, and grams of formaldehyde per brake horsepower-hour.
- b. Subsequent performance testing shall be performed every five (5) years, within 90 days of the anniversary date of the initial test.
- c. Utilize one of the following USEPA test methods: Method 320 or 323 of 40 CFR Part 63, appendix A; ASTM D6348-03, provided in ASTM D6348-03 Annex A5 (Analyte Spiking Technique); or alternative test method approved by the Department.

### 3. Monitoring

- a. Continuously monitor the amount of landfill gas combusted, and record in cubic feet per month.
- b. Monitor and record the methane content of the landfill gas as fired at least once per month, in percent methane.

- c. Equip each engine with a non-resettable hour meter to monitor the hours of operation.
- d. Label each engine with a unique identification number and cross referenced to the Department's process identification in the applicable air permit and air emission inventory.

C. Record Keeping:

- 1. To demonstrate compliance with the requirements of the presumptive BACT, an owner or operator using this presumptive BACT is required to keep the following records. These records are to be kept for five (5) years on-site or readily accessible and made available for review upon request by the Department.
  - a. The total hours of operation of each engine, in hours per week, as recorded by a non-resettable hour meter.
  - b. Records of all required engine maintenance, including:
    - (i) The date and current hour meter reading of any maintenance activity.
    - (ii) A description of each maintenance activity (i.e., oil change, spark plugs changed, hoses and belts replaced).
    - (iii) The length of time the engine was out of service.
    - (iv) If the engine is involved in an oil analysis program: the results from each oil analysis which include the Total Acid Number, viscosity, and percent water content and whether their condemning limits, as defined in B.1.a., are exceeded.
  - c. A copy of the maintenance plan for the SI RICE, or a copy of the facility's own maintenance plan for the SI RICE.
  - d. A copy of the operation and maintenance plan for pre-engine landfill gas treatment or conditioning systems, and maintenance records for these items;
  - e. Records of emission testing. These records shall, at a minimum, include:
    - (i) The date of each emission test.
    - (ii) An identification of each engine tested.
    - (iii) The results of each emission test, in pounds of formaldehyde emitted per hour, pounds of formaldehyde emitted per MMBTU of landfill gas combusted, and grams of formaldehyde per brake horsepower-hour.
  - f. The combined amount of landfill gas combusted in the engines for each calendar month, in cubic feet
  - g. The methane content of the landfill gas, as fired.
  - h. Supporting documentation for the calculation of the Threshold Energy Price as outlined in Section 3.A. (Presumptive BACT Applicability).