Central Sanitary Landfill & Recycling Center
3000 N.W. 48th Street
Pompano Beach, Florida 33073
305/977-9551

A Waste Management Company

August 9, 1993

RECEIVED

AUG 10 1993

Division of Air
Resources Management

Mr. John C. Brown, Jr.
Florida Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Dear Mr. Brown:

SUBJECT: FILE #AC13-218495
MEDLEY LANDFILL FLARE APPLICATION

We have revised the referenced permit application in accordance with your letter dated July 21, 1993. We have also reviewed the original submittal and compared it with the revision pages provided to verify that the necessary corrections have been made.

Revisions included in this submittal include page numbers to the calculation pages, an additional calculation for stack flow exit velocity, revised flow exit velocity on page 6 of 12 of the permit application, and correction of a typographical error in the "Expected Emission" column of the calculations.

We trust that this information will allow a determination that the application is complete in order to complete the permit process. If you have any questions, please call Richard Dormier at (305) 977-9551, Ext. 47.

Sincerely,

Richard A. Dormier
for Michael J. Berg
General Manager

RD/dt

cc: E. L. Anderson
M. Ardiff
J. Barrett
S. Brooks
R. Dormier
S. McCallister
File 1.1

Printed on recycled paper

FLARE SYSTEM AIR PERMIT APPLICATION

GAS FLOW RATE AND EXIT VELOCITY

This analysis will assume constant maximum landfill gas flow rate.

Maximum landfill gas flow rate = 1,250 scfm

Maximum concentration of methane in landfill gas is 60%, 40% CO_2.

Calculate gas exit velocity:

Flare designed to achieve minimum of 98% destruction efficiency of total hydrocarbons in accordance with EPA criteria 40 CFR 60.18.

To achieve destruction efficiency, gas exit velocity at flare tip must be less than 60 ft./sec. with net heating value of gas maintained at 200 BTU/scfm or greater.

With methane content of 40% - 60%, the net gas heating value would be between 404-607 BTU/scfm.

Flare tip and tip velocity:
Assume tip temperature of 120°F and a gas flow of 1,250 scfm (maximum design capacity for flare).

Flow corrected for 120°F =

$$1{,}250 \text{ scfm} \times \frac{460 + 120}{520} = 1394 \text{ ACFM}$$

$$\text{Flare tip velocity} = \frac{\text{actual flow}}{\text{tip cross-sectional area}}$$

$$= \frac{1394 \text{ ACFM}}{\dfrac{\pi \times 14^2 \text{ in.}}{4 \times 144 \dfrac{in^2}{ft^2}}} = 1304 \text{ fpm}$$

$$= \frac{1304 \text{ fpm}}{60 \dfrac{sec}{min}} = 21.7 \text{ ft/sec} < 60 \text{ ft/sec}$$

Utilization Rate:

CH_4 = 1250 scfm x 60/100 x 16 lb/lb mol x 1/359 lb mol/ft^3

x 60 min/hour = 2006 lbs/hr.

CO_2 = 1250 scfm x 40/100 x 44 lb/lbmol x 1/359 lbmol/ft^3 x

60 min/hr = 3677 lbs/hr.

H_2S = 1250 scfm x .0004/100 x 34 x 1/359 x 60 =0.03 lbs/hr.=0.

TOTAL INPUT RATE = 2006 + 3677 +0.03 = 5,683 lbs/hr.

Air needed for combustion at 1400° F.

$$1250 \text{ scfm} \times 60\% \times 31.42 \ \frac{\text{scfm air}}{\text{scfm } CH_4} = 23{,}565 \text{ scfm.}$$

Total product flow = 1,250 scfm + 23,565 scfm = 24,815 scfm.

Combustion heat release:

1,250 scfm x 60/100 x 1,012 BTU/ft^3 CH^4 x 60 =

45,540,000 BTU/hr.

Theoretical stack effluent at 1400° F.

Combustion Temp:

N_2 = 75%
O_2 = 13.9%
CO_2 = 5.04%
H_2O = 6.045%

Stack Effluent by weight:

N_2 = 24,815 scfm x .75 x 28 lb/lbmol x 60 min/hr. x 1/359 lbmol/ft^3 = 87,094 lbs/hr.

O_2 = 24,815 scfm x .139 x 32 lb/lbmol x 60 x 1/359 = 18,447 lb/hr

CO_2 = 24,815 scfm x .0504 x 44 lb/lbmol x 60 x 1/359 = 9,197 lbs/hr.

H_2O = 24,815 scfm x .06045 x 18 lb/lbmol x 60 x 1/359 = 4,513 lbs/hr.

Product Weight:

87,094 + 18,447 + 9,197 + 4,513 = 119,251 lbs/hr.

Expected Emission:

NO_x = 12 PPMV

CO = 480 PPMV

NO_x = $12/10^6$ x 24,815 scfm x 46 lb/lbmol x 1/359 x 60 = 2.29 lbs/hr.

CO = $480/10^6$ x 24,815 x 28 lb/lbmol x 1/359 x 60 = 55.74 lbs/hr.

SO_2 = mols in = mols out = $\frac{0.03 \times 64}{34}$ = 0.06 lbs/hr.

Convert to Tons/Year:

N_2 = 87,094 lbs/hr x 24 hr/day x 365 days/year x 1 ton/2000 lbs = 381,472 tons/year.

O_2 = 18,447 lbs/hr x 24 x 365 x 1 ton/2000 lbs = 80,798 tons/year.

CO_2 = 9,197 lbs/hr x 24 x 365 x 1 ton/2000 lbs = 40,283 tons/year.

H_2O = 4,513 lbs/hr x 24 x 365 x 1 ton/2000 lbs = 19,767 tons/year.

NO_x = 2.29 lbs/hr. x 24 x 365 x 1 to/2000 lbs. = 10 tons/year.

CO = 55.74 lbs/hr x 24 x 365 x 1 ton/2000 lbs.=244 tons/year.

SO_2 = 0.06 lbs/hr x 24 x 365 x 1 ton/2000 lbs.=0.26 tons/year.

Gas Flow Exit Velocity:

Gas inflow rate = 1250 scfm at 60% methane
Methane inflow rate = 1250 scfm x 0.6 = 750 scfm
Total air required = 31.416 cf air/cf methane
Total air required = 750 scfm x 31.416 = 23,562 scfm
Flare cross section area = $(\pi)(14\ in^2) \div (4)(144\ in^2/ft^2) = 1.07\ ft^2$
Exit velocity = total flow/area = 23,562 scfm $\div$ ($1.07\ ft^2$) (60 sec/min) = 367 ft/sec

H. Emission Stack Geometry and Flow Characteristics (Provide data for each stack):* *

Stack Height: 34' ft. Stack Diameter: 14" ft.

Gas Flow Rate: 1250 ACFM ______ DSCFM Gas Exit Temperature: 840 °F.

Water Vapor Content: ______ % Velocity: 367 FPS

SECTION IV: INCINERATOR INFORMATION

Not Applicable

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated							
Uncontrolled (lbs/hr)							

Description of Waste ______

Total Weight Incinerated (lbs/hr) ______ Design Capacity (lbs/hr) ______

Approximate Number of Hours of Operation per day ______ day/wk ______ wks/yr. ______

Manufacturer ______

Date Constructed ______ Model No. ______

	Volume $(ft)^3$	Heat Release (BTU/hr)	Fuel Type	Fuel BTU/hr	Temperature (°F)
Primary Chamber					
Secondary Chamber					

Stack Height: ______ ft. Stack Diamter: ______ Stack Temp. ______

Gas Flow Rate: ______ ACFM ______ DSCFM* Velocity: ______ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) ______

REVISED 8/9/93

Florida Department of
Environmental Protection

Lawton Chiles
Governor

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Virginia B. Wetherell
Secretary

July 21, 1993

Mr. Richard A. Dormier
Site Engineer
Central Disposal
3000 N. W. 48th Street
Pompano Beach, FL 33073

Dear **Mr. Dormier:**

SUBJECT: File No. AC13-218495
City of Medley Landfill Flare Application

Thank you for your letter dated July 2, 1993 on the subject application, written in response to our incompleteness letter of May 4, 1993. We have reviewed all documentation provided by your company in support of this application, and request that you provide the following remaining items, to allow a final completeness determination to be made:

1. A revised page 6 of the Application, with the appropriate gas flow exit velocity figure (496 feet per second is indicated).

2. A revised calculation sheet that computes "Expected Emission" of SO_2 (SO_4 is indicated).

Sincerely,

John C. Brown, Jr., P. E.
Administrator
Air Permitting and Standards

cc: J. Waters, Waste Management of North America
H. Bush, Jr., Waste Management of North America
S. Brooks, Southeast District FDEP
E. Anderson, Metro-Dade Center Environmental Resources Management
T. Cascio, Florida DEP

Is your RETURN ADDRESS completed on the reverse side?

SENDER:
- Complete items 1 and/or 2 for additional services.
- Complete items 3, and 4a & b.
- Print your name and address on the reverse of this form so that we can return this card to you.
- Attach this form to the front of the mailpiece, or on the back if space does not permit.
- Write "Return Receipt Requested" on the mailpiece below the article number.
- The Return Receipt will show to whom the article was delivered and the date delivered.

I also wish to receive the following services (for an extra fee):

1. ☐ Addressee's Address
2. ☐ Restricted Delivery

Consult postmaster for fee.

3. Article Addressed to:
Mr. Richard A. Dormier
Site Engineer
Central Disposal
3000 N.W. 48th Street
Pompano Beach, FL 33073

4a. Article Number
P 230 523 752

4b. Service Type
☐ Registered ☐ Insured
☒ Certified ☐ COD
☐ Express Mail ☐ Return Receipt for Merchandise

7. Date of Delivery 7-26

5. Signature (Addressee)

8. Addressee's Address (Only if requested and fee is paid)

6. Signature (Agent) M. Adams

PS Form 3811, December 1991 ★U.S. GPO: 1992—323-402 **DOMESTIC RETURN RECEIPT**

Thank you for using Return Receipt Service.

P 230 523 752

Receipt for Certified Mail
No Insurance Coverage Provided
Do not use for International Mail
(See Reverse)

UNITED STATES POSTAL SERVICE

Sent to Mr. Richard A. Dormier	
Street and No. Central Disposal 3000 N.W. 48th Street	
P.O., State and ZIP Code Pompano Beach, FL 33073	
Postage	$
Certified Fee	
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt Showing to Whom & Date Delivered	
Return Receipt Showing to Whom, Date, and Addressee's Address	
TOTAL Postage & Fees	$
Postmark or Date Permit: AC13-218495 Mailed: 7-22-93	

PS Form 3800, June 1991

A Waste Management Company

RECEIVED

JUL 06 1993

Division of Air Resources Management

July 2, 1993

Mr. John C. Brown, Jr.
Florida Department of Environmental Regulations
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Dear Mr. Brown:

SUBJECT: FILE #AC13-218495
MEDLEY LANDFILL FLARE APPLICATION

We have reviewed your letter of May 4, 1993 and have discussed our previous submittals with the flare manufacturer. It appears that we have provided you with the most conservative estimate of CO emissions possible, due to the difficulty in measuring emissions in a utility flare. The 613 tons per year for CO emission in our January 25, 1993 letter is based on a CO concentration of 480 ppmv. This concentration is only achieved assuming 2% of the gas is not destructed and the maximum CO is produced. We believe that in excess of 98% of the gas will be destructed, but we cannot document this due to the previously-mentioned difficulty in monitoring flare emissions directly at the flare.

In order to utilize the currently-installed system within the parameters outlined in your letter dated May 4, 1993, we propose to reduce the flow of gas through the flare to a maximum rate of 1,250 scfm. This flow rate is comparable to that listed in our modification to permit number SC13-179974, which was issued by the Florida Department of Environmental Regulation on March 31, 1992. This will result in a maximum CO emission of 244 tons per year, assuming 98% destruction and that all available non-destructed gas is converted to CO.

If the proposed flow rate of 1,250 scfm is insufficient to effectively control odor or gas migration, we would propose an option to perform air testing and modeling at the site to demonstrate the flare emissions. We believe that a higher destruct rate will occur (than the 98% assumed), resulting in lower CO emissions. If the modeling proves satisfactory, we would seek a modification to increase the flow rate, remaining within the allowable CO emissions rate of 250 tons/year. If we choose not to perform the modeling or if modeling did not provide acceptable results, we would then consider other alternatives to reduce CO emissions such as an enclosed flare or a turbine to generate electricity.

Your letter dated May 4, 1993 asked the year that Medley landfill began operations. We believe the site began operations in the mid-1950's by a private sanitation company. Several private firms owned and operated the site until 1980, when Waste Management, Inc. of Florida purchased the landfill.

We have revised appropriate pages in our January 25, 1993 letter and our original application dated August 26, 1992. These are marked with revision dates on the bottom of the pages.

We hope this clarifies your concerns and resolves all outstanding issues. As previously discussed, we believe that operation of the flare system is necessary in order for us to comply with our permit regarding odor control and gas migration. Should you have any questions or need additional information, please call Richard Dormier at (305) 977-9551, Ext. 47.

Sincerely,

Michael J. Berg
General Manager

Enclosures

RD:dt

cc: Mary Ardiff
Jim Barrett
Richard Dormier
Scott McCallister
File 1.1

FLARE SYSTEM AIR PERMIT APPLICATION

GAS FLOW RATE AND EXIT VELOCITY

This analysis will assume constant maximum landfill gas flow rate.

Maximum landfill gas flow rate = 1,250 scfm

Maximum concentration of methane in landfill gas is 60%, 40% CO_2.

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To achieve destruction efficiency, gas exit velocity at flare tip must be less than 60 ft./sec. with net heating value of gas maintained at 200 BTU/scfm or greater.

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Assume tip temperature of 120°F and a gas flow of 1,250 scfm (maximum design capacity for flare).

Flow corrected for 120°F =

$$1{,}250 \text{ scfm} \times \frac{460 + 120}{520} = 1394 \text{ ACFM}$$

$$\text{Flare tip velocity} = \frac{\text{actual flow}}{\text{tip cross-sectional area}}$$

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$$= \frac{1304 \text{ fpm}}{60 \, \dfrac{\text{sec}}{\text{min}}} = 21.7 \text{ ft/sec} < 60 \text{ ft/sec}$$

Utilization Rate:

CH_4 = 1250 scfm x 60/100 x 16 lb/lb mol x 1/359 lb mol/ft^3 x 60 min/hour = 2006 lbs/hr.

CO_2 = 1250 scfm x 40/100 x 44 lb/lbmol x 1/359 lbmol/ft^3 x 60 min/hr = 3677 lbs/hr.

H_2S = 1250 scfm x .0004/100 x 34 x 1/359 x 60 =0.03 lbs/hr.=0.

TOTAL INPUT RATE = 2006 + 3677 +0.03 = 5,683 lbs/hr.

Air needed for combustion at 1400° F.

$$1250 \text{ scfm} \times 60\% \times 31.42 \frac{\text{scfm air}}{\text{scfm } CH_4} = 23{,}565 \text{ scfm.}$$

Total product flow = 1,250 scfm + 23,565 scfm = 24,815 scfm.

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1,250 scfm x 60/100 x 1,012 BTU/ft^3 CH^4 x 60 =

45,540,000 BTU/hr.

Theoretical stack effluent at 1400° F.

Combustion Temp:

N_2 = 75%
O_2 = 13.9%
CO_2 = 5.04%
H_2O = 6.045%

Stack Effluent by weight:

N_2 = 24,815 scfm x .75 x 28 lb/lbmol x 60 min/hr. x 1/359 lbmol/ft^3 = 87,094 lbs/hr.

O_2 = 24,815 scfm x .139 x 32 lb/lbmol x 60 x 1/359 = 18,447 lb/hr

CO_2 = 24,815 scfm x .0504 x 44 lb/lbmol x 60 x 1/359 = 9,197 lbs/hr.

H_2O = 24,815 scfm x .06045 x 18 lb/lbmol x 60 x 1/359 = 4,513 lbs/hr.

Product Weight:

87,094 + 18,447 + 9,197 + 4,513 = 119,251 lbs/hr.

Expected Emission:

NO_x = 12 PPMV

CO = 480 PPMV

NO_x = $12/10^6$ x 24,815 scfm x 46 lb/lbmol x 1/359 x 60 = 2.29 lbs/hr.

CO = $480/10^6$ x 24,815 x 28 lb/lbmol x 1/359 x 60 = 55.74 lbs/hr.

SO_4 = mols in = mols out = $\frac{0.03 \times 64}{34}$ = 0.06 lbs/hr.

Convert to Tons/Year:

N_2 = 87,094 lbs/hr x 24 hr/day x 365 days/year x 1 ton/2000 lbs = 381,472 tons/year.

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NO_x = 2.29 lbs/hr. x 24 x 365 x 1 to/2000 lbs. = 10 tons/year.

CO = 55.74 lbs/hr x 24 x 365 x 1 ton/2000 lbs.=244 tons/year.

SO_2 = 0.06 lbs/hr x 24 x 365 x 1 ton/2000 lbs.=0.26 tons/year.

the pollution control facilities, when properly maintained and operated, will discharge an effluent that complies with all applicable statutes of the State of Florida and the rules and regulations of the department. It is also agreed that the undersigned will furnish, if authorized by the owner, the applicant a set of instructions for the proper maintenance and operation of the pollution control facilities and, if applicable, pollution sources.

Signed [signature]

Harvey H. Bush, Jr., P.E.
Name (Please Type)

Waste Management Inc.
Company Name (Please Type)

500 Cypress Creek Rd., Suite 300
Ft. Lauderdale, FL 33309
Mailing Address (Please Type)

Florida Registration No. 6267 Date: 7/2/93 Telephone No. 305/771-9850

SECTION II: GENERAL PROJECT INFORMATION

A. Describe the nature and extent of the project. Refer to pollution control equipment, and expected improvements in source performance as a result of installation. State whether the project will result in full compliance. Attach additional sheet if necessary.

Landfill gas collection system utilizing a flare for efficient thermal disposal of landfill gas consisting of approx. 60% CH_4 and 40% CO_2. Gas flow rate is estimated at 1250 CFM.

B. Schedule of project covered in this application (Construction Permit Application Only)

Start of Construction 4/92 Completion of Construction 8/92

C. Costs of pollution control system(s): (Note: Show breakdown of estimated costs only for individual components/units of the project serving pollution control purposes. Information on actual costs shall be furnished with the application for operation permit.)

Flare price = $100,000

D. Indicate any previous DER permits, orders and notices associated with the emission point, including permit issuance and expiration dates.

Landfill gas collection system installation permitted as modification to solid waste permit, SC-13-179974

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

.. Raw Materials and Chemicals Used in your Process, if applicable:

Description	Contaminants Type	Contaminants % Wt	Utilization Rate - lbs/hr	Relate to Flow Diagram
LANDFILL GAS	CH_4	60		
	CO_2	35	1250 scfm	
	H_2S	0.0004		

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): 1250 scfm

2. Product Weight (lbs/hr): ____________

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

Name of Contaminant	Emission[1]* Maximum lbs/hr	Emission[1]* Actual T/yr	Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission lbs/yr	Potential[4] Emission T/yr	Relate to Flow Diagram
N_2	87,094	381,472	**		same as maximum		
O_2	18,447	80,798	**		emissions		
CO_2	9,197	40,283	**				
H_2O	4,513	19,767	**				
NO_x	2.29	10	**				
CO	55.74	244	**				
SO_2	0.06	0.26	**				

[1]See Section V, Item 2.

[2]Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3]Calculated from operating rate and applicable standard.

[4]Emission, if source operated without control (See Section V, Item 3).

* Based on maximum flow rate
** Not specified in F.A.C. 17-2.600 emission limiting and performance standards for a landfill gas flare.

H. Emission Stack Geometry and Flow Characteristics (Provide data for each stack):* ✱

Stack Height: 34' ft. Stack Diameter: 14" ft

Gas Flow Rate: 1250 ACFM ______ DSCFM Gas Exit Temperature: 840 °F

Water Vapor Content: ______ % Velocity: 496 FPS

SECTION IV: INCINERATOR INFORMATION

Not Applicable

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated							
Uncontrolled (lbs/hr)							

Description of Waste ______

Total Weight Incinerated (lbs/hr) ______ Design Capacity (lbs/hr) ______

Approximate Number of Hours of Operation per day ______ day/wk ______ wks/yr. ______

Manufacturer ______

Date Constructed ______ Model No. ______

	Volume (ft)^3	Heat Release (BTU/hr)	Fuel Type	Fuel BTU/hr	Temperature (°F)
Primary Chamber					
Secondary Chamber					

Stack Height: ______ ft. Stack Diamter: ______ Stack Temp. ______

Gas Flow Rate: ______ ACFM ______ DSCFM* Velocity: ______ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) ______

Gas Analysis for Sulphur

A Waste Management Company

July 2, 1993

RECEIVED

JUL 0 6 1993

Division of Air Resources Management

Mr. John C. Brown, Jr.
Florida Department of Environmental Regulations
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Dear Mr. Brown:

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Product Weight:

87,094 + 18,447 + 9,197 + 4,513 = 119,251 lbs/hr.

Expected Emission:

NO_x = 12 PPMV

CO = 480 PPMV

NO_x = $12/10^6$ x 24,815 scfm x 46 lb/lbmol x 1/359 x 60 = 2.29 lbs/hr.

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Water Vapor Content: ______ % Velocity: 496 FP

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Not Applicable

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Patholog-ical)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Inciner-ated							
Uncon-trolled (lbs/hr)							

Description of Waste ______

Total Weight Incinerated (lbs/hr) ______ Design Capacity (lbs/hr) ______

Approximate Number of Hours of Operation per day ______ day/wk ______ wks/yr. ______

Manufacturer ______

Date Constructed ______ Model No. ______

	Volume $(ft)^3$	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
Primary Chamber					
Secondary Chamber					

Stack Height: ______ ft. Stack Diamter: ______ Stack Temp. ______

Gas Flow Rate: ______ ACFM ______ DSCFM* Velocity: ______ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) ______

Florida Department of Environmental Regulation

Twin Towers Office Bldg. • 2600 Blair Stone Road • Tallahassee, Florida 32399-2400

Lawton Chiles, Governor

Virginia B. Wetherell, Secretary

May 4, 1993

Mr. Richard A. Dormier
Site Engineer
Central Disposal
3000 N. W. 48th Street
Pompano Beach, FL 33073

Dear Mr. Dormier:

SUBJECT: File No. AC13-218495
City of Medley Landfill Flare Application

Thank you for your letter dated April 13, 1993 on the subject application, written in response to our incompleteness letter of February 26, 1993. We have reviewed all documentation provided by your company in support of this application, and have drafted a preliminary assessment (attached) that summarizes current project status.

Please note that based on our analysis your application to construct the flare is still deemed incomplete. As indicated in the attached, the potential to emit the pollutant carbon monoxide (CO) exceeds the significance level threshold, and thus the application is subject to New Source Review (NSR).

Since the proposed project is in an attainment area for CO, Prevention of Significant Deterioration (PSD) requirements must be adhered to, and Best Available Control Technology (BACT) is required if the project is to be implemented. Also, PSD mandates that an Ambient Impact Analysis, including both air quality impacts, and additional impacts (e. g., soils, vegetation) be part of the application.

We would be most happy to meet with you to discuss these requirements in detail. If you require further clarification, please contact Tom Cascio of my staff on 904-488-1344.

Sincerely,

John C. Brown, Jr.

John C. Brown, Jr., P. E.
Administrator
Air Permitting and Standards

cc: J. Waters, Waste Management of North America
H. Bush, Jr., Waste Management of North America
S. Brooks, Southeast District FDER
E. Anderson, Metro-Dade Center Environmental Resources Management
T. Cascio, Florida DER

ATTACHMENT

PRELIMINARY ASSESSMENT 5/04/93

WASTE MANAGEMENT OF NORTH AMERICA

CITY OF MEDLEY LANDFILL FLARE

DADE COUNTY, FLORIDA

PERMIT APPLICATION NUMBER: AC 13-218495

I. Application

A. Applicant

Harvey H. Bush, Jr., Senior Environmental Vice President
Waste Management of North America
500 Cypress Creek Road, Suite 300
Fort Lauderdale, FL 33309

B. Project and Location

Waste Management of North America has applied for a construction permit to install a flare for the collection and disposal of all active gases at the City of Medley Sanitary Landfill and Recycling Center. This facility is located at 9350 NW 89th Street, Medley, Dade County, Florida. The source Latitude is 25° 51′ 31″ N, Longitude is 80° 21′ 03″ W.

Installation of the gas collection system is a specific condition (No. 22) of Florida Department of Environmental Regulation Solid Waste Permit No. SC13-177974, held by the applicant.

C. Facility Category

The SIC Code is 4953 and the SCC Code is 5-01-001-02.

Waste Management of North America applied for a construction permit on September 1, 1992, and **application completeness is currently under review.**

II. Project Description

Waste Management of North America has applied for a construction permit for a flare for the collection and disposal of active gases at the City of Medley Sanitary Landfill and Recycling Center. Today, the gas collection system consists of 48 existing wells. The wells will be manifolded together and routed to the flare where the gas will be burned to oxidize potential odor causing constituents, and destroy the potentially explosive gases. It is expected that additional wells will be installed as the landfill expands.

It is estimated that gas flow from each of the existing wells will equal 38 cubic feet per minute (cfm), resulting in an average total of 1824 cfm for the system as it exists today. The **upper limit** of gas flow for all wells eventually installed is estimated at 3140 cfm. Design limit of the flare is set at 3210 cfm maximum. It will normally be operated at 1400° F. Flare tip velocity, assuming 3140 scfm gas flow, is estimated at 55 ft/sec.

III. Rule Applicability

The City of Medley Sanitary Landfill and Recycling Center started solid waste disposal operations in ________ [applicant please provide date] and is located in Dade County, an area designated nonattainment (moderate) for ozone (17-275.410), and attainment for the other criteria pollutants (17-275.400).

Sanitary landfills are not listed in Table 212.400-1, Major Facility Categories (List of 28). This source is a major facility because the potential to emit carbon monoxide exceeds 100 tons per year (TPY) as per 17-212-200. **Since the potential to emit carbon monoxide exceeds 250 TPY, the source is subject to New Source Review -- Prevention of Significant Deterioration (PSD) (17.212-400).** Also, this source is subject to New Source Performance Standards (NSPS) requirements of 40 CFR 60.18. Application of Best Available Control Technology (BACT) (17.212.410) is required.

IV. Source Impact Analysis

Continuous operation of the proposed flare will result in the following expected emissions:

Pollutant	Tons per Year
NO_x	**25.**
CO	**613.**
SO_2	**0.57**

Is your RETURN ADDRESS completed on the reverse side?

SENDER:
- Complete items 1 and/or 2 for additional services.
- Complete items 3, and 4a & b.
- Print your name and address on the reverse of this form so that we can return this card to you.
- Attach this form to the front of the mailpiece, or on the back if space does not permit.
- Write "Return Receipt Requested" on the mailpiece below the article number.
- The Return Receipt will show to whom the article was delivered and the date delivered.

I also wish to receive the following services (for an extra fee):
1. ☐ Addressee's Address
2. ☐ Restricted Delivery

Consult postmaster for fee.

3. Article Addressed to:

Mr. Richard A. Dormier
Site Engineer
Central Disposal
3000 N.W. 48th Street
Pompano Beach, FL 33073

4a. Article Number
P 230 524 277

4b. Service Type
- ☐ Registered
- ☐ Insured
- ☒ Certified
- ☐ COD
- ☐ Express Mail
- ☐ Return Receipt for Merchandise

7. Date of Delivery
5-7

5. Signature (Addressee)
[signature]

6. Signature (Agent)

8. Addressee's Address (Only if requested and fee is paid)

PS Form **3811**, December 1991 ☆U.S. GPO: 1992—323-402 **DOMESTIC RETURN RECEIPT**

Thank you for using Return Receipt Service.

P 230 524 277

Receipt for Certified Mail

No Insurance Coverage Provided
Do not use for International Mail
(See Reverse)

Sent to: Mr. Richard A. Dormier	
Street and No.: Central Disposal 3000 NW 48th St.	
P.O., State and ZIP Code: Pompano Beach, FL 33073	
Postage	$
Certified Fee	
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt Showing to Whom & Date Delivered	
Return Receipt Showing to Whom, Date, and Addressee's Address	
TOTAL Postage & Fees	$

Postmark or Date
Mailed: 5-4-93
Permit: AC13-218495

PS Form **3800**, June 1991

Central Disposal
3000 N.W. 48th Street
Pompano Beach, Florida 33073
305/977-9551

Preston

A Waste Management Company

RECEIVED

APR 14 1993

Division of Air
Resources Management

April 13, 1993

Mr. John C. Brown, Jr.
Florida Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Dear Mr. Brown:

SUBJECT: File No. AC13-218495
Medley Landfill Flare Application
Request for Additional Information

Submitted herein are responses to comments in your letter dated February 26, 1993 pertaining to the above-referenced application. We have discussed each of your comments with the manufacturer of the flare and believe the following provides the information requested. We have also included a paper titled "Destruction of Landfill Gas by Thermal Oxidation" by Mr. James C. Franklin. This paper was presented at the GRCDA 13th Annual International Landfill Gas Symposium in March, 1990 and was used as a reference for some of the information presented below.

Comment No. 1

Please provide the derivation and/or reference for the 31.42 factor utilized to compute the air needed for combustion at 1400°F.

The air needed for combustion was determined for us by the manufacturer by performing a thermal balance calculation for the gas as follows:

(Combustion heat release) = (Gas specific energy)(Gas effluent)(Increase in Temperature)

The attached paper indicates that excess air or quench air needed for combustion at 1400°F. = 230% of the combustion air requirement.

Per the stoichiometric equation:

$$CH_4 + \underbrace{2O_2 + 7.52\ N_2}_{9.52} \rightarrow CO_2 + 2H_2O = 7.52\ N_2$$

To combust 1 cubic foot of Methane would require 9.52 cubic feet of air.

Excess or quench air = (9.52 cubic feet) (230%) = 21.896 cubic feet.

Total air required = stoichiometric air + excess air
= 9.52 CF + 21.896 CF
= 31.416 CF

Comment No. 2

Please provide the derivation of the percentages on Page 2 for the "theoretical stack effluent at 1400°F. combustion temperature."

The stack effluent was determined utilizing a landfill gas composition of 50% methane and 50% CO_2, N_2, O_2 by utilizing the stoichiometric equation, adding the quench air venting through the flare, and determining the percentage of each constituent in the flue gas. The attached paper contains a table on Page 25 which lists flue gas composition for various operation conditions and is consistent with the information previously provided.

Please see attached copy of Gas Chromotagraph Analysis. This analysis was obtained at the Central Sanitary Landfill site and is representative of expected gas quality at Medley. Note: Actual data at Medley will be obtainable when the system is operational.

Comment No. 3

Please provide the basis for the "expected emissions" for NO_x and CO.

The manufacturer indicates that these values are taken from data generated at other landfill sites and based on their experience, can be considered very conservative. Additionally, we have enclosed annual Stack Test Results from the landfill gas turbines at Central Sanitary Landfill, which indicate actual NO_x emissions.

Comment No. 4

It appears that the calculation on Page 1 contains a typographical error, resulting in an erroneous "flare tip velocity" estimate.

We agree and have corrected the equation. A corrected page is attached for inclusion in the application.

We trust that this information will satisfy your concerns with our application to flare the landfill gas at Medley landfill. We believe the proposed system is necessary to satisfy our current permit to prevent/control odor as well as migration of methane and are prepared to begin operation of the system as soon as we receive your approval.

Please let us know if you have additional comments. If you desire, a meeting may be in order to finalize the review process. If you have any questions, please feel free to call me at (305) 977-9551, Ext. 47.

Sincerely,

Richard A. Dormier
Site Engineer

RAD/dt

Attachments

cc: J. Barrett
S. McCallister
M. Berg
L. Kolani

DESTRUCTION OF LANDFILL GAS BY THERMAL OXIDATION

JAMES C. FRANKLIN

MANAGER, STANDARD PRODUCTS
McGILL ENVIRONMENTAL SYSTEMS, INC., TULSA, OK

INTRODUCTION

Combustion has become a major method for disposing of many industrial byproducts and emissions. The prime objective in the combustion system is the safe, controlled disposal of the combustible portion of industrial wastes.

The art and technology of combustion systems seem to hold an unnecessary mystery and are often thought of as "black boxes". Although years of experience are required to develop detailed design expertise, the combustion process is controlled by fundamental principles. This presentation will discuss some of these fundamentals and provide criteria that will allow engineers, site managers, and operators to better evaluate and operate combustion equipment for landfill applications.

COMBUSTION FUNDAMENTALS

Combustion is fundamental to life - the transformation of food into energy, carbon dioxide, and water by a chemical reaction with oxygen in our bodies is one type of combustion. Gasoline is also reacted with oxygen to produce energy, carbon dioxide and water to run our cars. By utilising the combustion process to dispose of landfill gas, similar results are obtained. Energy is produced (fire, heat, and light) along with carbon dioxide and water when the landfill gas is reacted with the oxygen in air.

All of these combustion examples are forms of oxidation reactions. When oxidation occurs in large amounts and quickly, a burning fire results. Fundamental equations exist that will accurately predict all of the following:

1. The new compounds that are formed from each oxidation reaction.
2. The amount of oxygen required for each type of reaction.
3. The amount of energy released for each oxidation reaction.

LANDFILL GAS

Landfill gas typically consists of the following major components which react as follows when oxidized:

A. Methane: Methane is a compound that contains one carbon atom and four hydrogen atoms and is written as CH_4. When oxidized, the carbon atom forms carbon dioxide (CO_2) and the hydrogen forms water (H_2O). Each molecule of methane requires two molecules of oxygen (O_2) to supply the four oxygen atoms required for complete combustion. The formula for this reaction is written as follows:

$$\text{One } CH_4 + \text{two } O_2 = \text{one } CO_2 + \text{two } H_2O + \text{heat}$$

B. Carbon dioxide (CO_2) and water vapor (H_2O): These compounds already have the full amount of oxygen in them and therefore are not combustible and do not react. In other words, the carbon dioxide and water vapor in the landfill gas pass through the combustor unchanged chemically, although they will be heated up by the fire as all the gases are.

C. Oxygen in the landfill gas will react with the methane in the landfill gas just like oxygen in the air will.

D. Nitrogen (N_2) is typically an inert gas and although it does not have any oxygen in it, it does not oxidize easily. However, when nitrogen gets very hot, such as in a fire, an extremely small number of nitrogen molecules split apart. These single nitrogen atoms are reactive with oxygen and can form an undesirable compound called NOx. The "x" means the number of oxygen atoms that react with the single nitrogen atom can vary. If one oxygen atom reacts, then nitrogen oxide (NO) is formed. If two oxygen atoms react with one nitrogen, then nitrogen dioxide (NO_2) is formed. Nitrogen from the landfill gas and from the combustion air can react this way.

E. Landfill gas can have trace amounts of many other compounds which can react during the combustion process to form other compounds. These compounds vary from site to site and must be individually evaluated if they are governed by emission regulations.

AIR REQUIREMENTS

As discussed above, each molecule of methane requires two molecules of oxygen for combustion. Since air is 21% oxygen and 79% nitrogen, it takes 9.5 molecules of air to supply the two molecules of oxygen. One SCF (Standard Cubic Foot) of gas contains the same number of molecules no matter what the type of gases are. Therefore, each SCF of methane requires 9.5 SCF of air for combustion. The 9.5 SCF of air is considered the "theoretical" air requirement to combust methane. To assure the reaction occurs efficiently, additional air is needed which is called excess air. Typically, a minimum of 10 to 20% excess air is needed to maintain a high destruction efficiency. Since the oxidation reaction releases energy in the form of heat, the reaction must be cooled to keep the temperature from getting too hot. This is normally done by adding extra air, which is called "quench air". Quench air is often greater than the combustion air flow and can result in a total excess air requirement of 100 to 250% above the theoretical combustion air required.

The following table illustrates the effect of operating temperature on flue gas flow rates and excess air levels based on 100 cfm of landfill gas (50% methane, 30% CO_2, 10% N_2, 10% H_2O):

Operating Temperature (°F)	Flue Gas Flow (scfm)	Excess Air (%)	Flue Gas Composition CO_2	N_2	O_2	H_2O
			—vol% (wet basis)—			
→ 1400	1690	230	4.8	74.3	13.6	7.4 ←
1600	1440	179	5.6	73.6	12.3	8.5
1800	1250	140	6.4	72.9	11.1	9.6
2000	1100	108	7.3	72.1	9.8	10.8

ENERGY RELEASED

Each SCF of pure methane releases 910 Btu's of energy. If a landfill gas is only 50% methane, the gas will have only 455 Btu's of energy per SCF.

Example: Assume a landfill has 120,000 SCF per hour of waste gas at 50% methane. The gas will release 455 Btu's per SCF. This results in a total release of 54.6 million Btu's per hour. If the methane concentration is 60%, the gas will release 541 Btu's per SCF. For the same flow rate, the 60% methane will release 65.5 million Btu's per hour.

DESIGN PARAMETERS

Although the above fundamentals are well understood, the actual mechanism for combustion is complex with numerous intermediate compounds formed before the final destruction efficiency is achieved. In the ideal situation, only CO_2, H_2O, O_2, and N_2 are present in the combustion flue gas. In reality, low concentrations of CO, unburned hydrocarbons, acid gases (HCl, SO_2/SO_3) and nitrogen oxides are present in the flue gas plus other contaminants, dependent on the composition of the waste. Numerous authors have suggested a simplified first order combustion model to predict destruction efficiency, which is shown in Table 2.

TABLE 2

$$\frac{dc}{dt} = k[C]$$

Where $k = A.\exp[-E/RT]$ (Arrhenius Rate Equation)

Solving for C, gives

$$C/_{Co} = \exp.(-k.t)$$

Where: A = Factor for each compound
E = Activation energy of each compound
R = Gas constant
T = Temperature (absolute)
C = Final concentration of compound
Co = Initial concentration of compound
t = Residence time in incinerator

Note: 'A' and 'E' can be experimentally determined.

Solving for D.E.,

$$D.E. = 1 - {}^{C}/_{Co}$$

It is therefore possible to solve for C/Co which gives the Destruction Efficiency (DE) of the compounds.

As shown in Table 1, the destruction efficiency is dependent on the temperature and combustion residence time. These are two of the "Three T's of Combustion: residence time, operating temperature and burner turbulence. The process variables are interrelated and, to some extent, dependent upon each other. For example, better burner turbulence can reduce the required residence time needed for a specific destruction efficiency, and vice versa. Operating temperature, residence time, and burner design must all be considered in the selection and evaluation of landfill gas combustion equipment.

The combustion temperature should be a minimum of 300 - 500°F above the autoignition temperature of the waste gas to ensure good destruction. Since methane autoignites at 1004°F, a minimum operating temperature of 1400°F is often specified. However, since the landfill gas reaction is exothermic (no additional fuel required), the ability to combust at 1800-2000°F improves the hydrocarbon destruction efficiency.

The residence time in a combustor allows time for the hydrocarbons to thoroughly heat up and mix well to react with oxygen. Residence times for volatile organic compounds (VOCs) vary from 0.25 to 2.0 seconds. Solid particles, such as carbon, may require up to 5 seconds for total destruction.

Turbulence is the final design parameter and the one most dependent upon the burner design. Mixing of landfill gas and air at the burner tip is the most critical operation of the combustion equipment. Proper turbulence creates a uniform mix of landfill gas and air in the combustion zone. Poor mixing leads to flue gas stratification which contributes to high emissions and operating instability.

OPEN FLAME COMBUSTORS

Open flame combustors, also known as "candle" or "pipe" flares, have been widely used on landfills for years. Often no more sophisticated than an open pipe lit periodically with a burning rag, pipe flares offer an economical method of disposing of the landfill gas. In the simplest form, the pipe flares were placed one to each relief well and operated at reservoir pressures.

As environmental and odor controls became stricter, many landfill operators have installed gas collection systems to prevent gas migration outside of the landfill boundaries. Suction wells drilled at engineered locations are tied together with common manifolds. Large blowers pull a slight vacuum and direct the landfill gas away from the property boundaries.

Likewise, the open flame flares have changed as well. A single flare is often required to serve the entire landfill. Operating at higher flow rates and tip velocities requires flame stabilizers to prevent the flame from extinguishing itself. Windshields allow the flame to establish itself and resist high wind conditions. Automatic energy saving pilots sense the landfill gas flame and automatically relight the flare if necessary.

Open flame flares are difficult to evaluate according to the Three T's of Combustion as the residence time and temperature cannot be controlled or accurately measured. The burner turbulence is a function of the landfill gas pressure drop which is often limited by the maximum stable tip velocity.

Emissions from open flame landfill flares have not been specifically studied to date. However, numerous studies have been performed on other open flame flares over the years with surprisingly consistent results on emissions. In general, the reports conclude that open flame flaring destroys over 98% of the total hydrocarbons provided that a stable flame exists.

(Figure 1 - Open Flare)

Although not presently a requirement everywhere, 40 CFR 16 stipulates a minimum Btu value for the waste gas and maximum allowable tip velocities for for open flares. Lower velocities are required for low Btu gases to maintain a stable flame.

This is an important distinction for landfill gases due to the variable inert gas levels. A study by the Chemical Manufacturers Association shows a 98% or higher hydrocarbon destruction level of various compounds in a propane/nitrogen mixture during stable flare operation. As the nitrogen content was increased, a definite point of instability was reached and destruction efficiencies quickly dropped to below 95%.

The main disadvantage to ALL open flame flares is the monitoring of emissions. Without a closed system design, it is impossible to accurately measure emissions. Sample probes placed too close to the flame will measure high CO and hydrocarbon levels. Samples taken away from the flame are diluted by an unknown amount of air. If the regulatory agencies require emission sampling or testing, an enclosed flare is needed.

ENCLOSED COMBUSTORS

Enclosed combustors differ from open flame flares in that both landfill gas and the air flows are controlled. While landfill gas is "pushed" through the burner tips by a blower, the stack "pulls" or drafts the air through air dampers and around the burner tips. Acting as a chimney, the stack height and diameter are crucial in developing sufficient draft and residence time for good operation.

Enclosed combustors are used in landfill gas applications for one of two reasons. An enclosed combustor may be required simply to hide all or part of the flame. Additionally, an enclosed combustor may be needed to assure present or future emission requirements are met, especially if monitoring is required.

Invisible Flares:

Enclosed combustors designed solely to hide the flame are often referred to as "invisible flares". These flares are normally characterized by a short stack height of 20 to 30 feet. Residence times are typically about 0.3 seconds.

(Figure 2 - Enclosed Combustor)

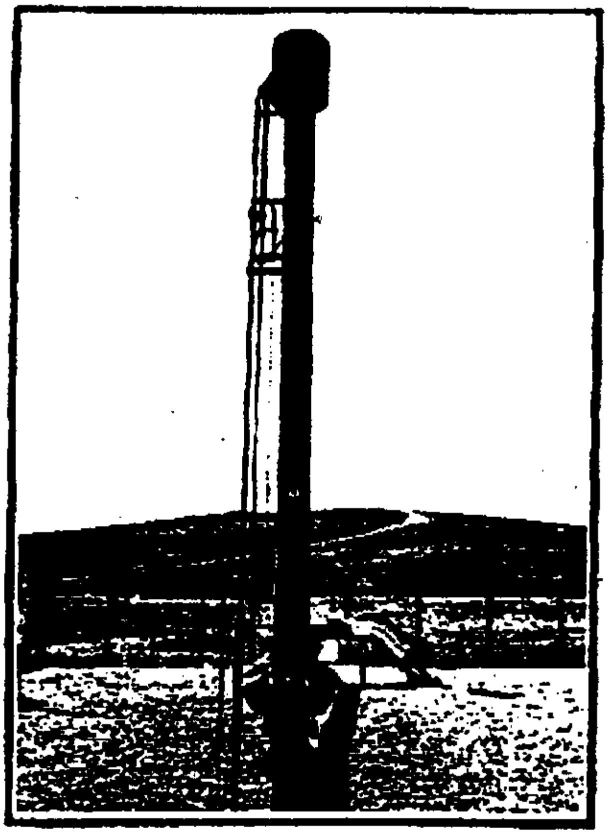

Figure 1 - Open Flare

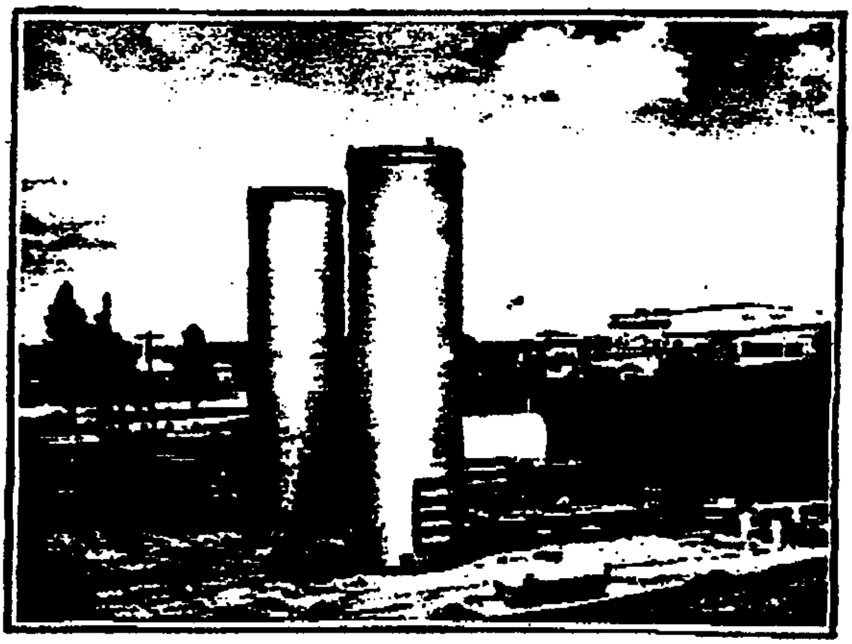

Figure 2 - Enclosed Combustor

At full landfill flow rates, the flame inside an invisible flare is often close to the top of the flare. In many cases, invisible flares are designed to enclose the "flame envelope", but allow" tails" of flame to burn above the top of the flare. As landfill gas is primarily methane and CO_2, the flame tails are clear and might only be seen at night. Landfills near residential areas or heavily traveled roads may find the fire department at the gate on occasion.

Emissions from invisible flares are very dependent upon the landfill gas flow and methane concentration. At low rates, the residence times are sufficient for complete combustion and the flame height is short enough for an accurate sample. At high rates, sampling tests may yield erratic results as combustion may not be complete at the sampling location. High CO and unburned hydrocarbon concentrations are not uncommon of invisible flares at high flow rates.

From the earlier discussion of the "Three T's of Combustion", the "turbulence" or mixing energy of invisible flares is low due to the short flare height with, consequently, a low air draft at the burners. The mixing energy comes from two sources, the landfill gas pressure and the air pressure drop. As the air flow is 10-15 times the gas flow, the importance of stack height on the burner operation becomes evident. Adding 20% to the stack height also adds 20-30% to the burner air mixing energy and residence time.

Emission Control Enclosed Combustors:

Enclosed combustors often need to minimize NOx, CO, and hydrocarbon emissions while at the same time maximize the destruction of trace compounds such as vinyl chloride and aromatic compounds. These requirements are often contradictory, requiring design compromises to maximize the flare performance. For example, high operating temperatures reduce CO and hydrocarbon emissions, but also increase the NOx levels. The enclosed combustor should be designed not only to meet today's emission regulations, but should also be able to operate at more stringent conditions if needed by future regulations.

Emission control enclosed combustors are characterised by a 35 - 50 ft. overall height. The additional height is a key design requirement for emission reduction as the flare height provides the draft and mixing energy for the landfill gas and combustion air. A 40 ft. enclosed flare will produce about 100% more draft than a 20 ft. enclosure. This draft is the key to completing the "Three T's" triangle of time, temperature, and turbulence.

Flare height may also be needed to meet sampling location regulations. California requires the flame to be several feet below the stack so sample ports can be properly located to get accurate emission and flowrate measurements.

-Landfill emission regulations have specified as low as 0.3 seconds minimum residence time, which is quite adequate for combustion of methane and to meet the total hydrocarbon emission standards of 98 - 99% destruction. However, trace compounds such as tetrachloroethylene and methylene chloride are more difficult to combust. McGill has standardized on the more stringent requirements of 0.6 - 1.0 seconds residence time to assure more complete destruction.

Operating temperature is a key design parameter for emission control and is often the least understood. Most regulations specify a minimum operating temperature if 1400°F which is suitable for combustion of methane and similar VOCs. In general, lower operating temperaures reduce NOx emissions by cooling the flame temperature. Increasing the operating temperature reduces CO and hydrocarbon emissions. As a rule of thumb, low CO emissions require 1600°F to ensure good conversion efficiencies. Higher residence times and good burner mixing can offset lower operating temperatures.

The mechanical design of the enclosed flare can also limit the maximum operating temperature. McGill uses 2600°F refractory and Inconel anchors which will withstand a continuous operating temperature of 2000°F. Due to the changing nature of emission regulations, McGill recommends that enclosed flares be designed to operate from 1400°F to 2000°F without mechanical damage in order to provide the maximum user flexibility.

FIELD EMISSION RESULTS

McGill emission control enclosed combustors have been tested at a number of locations. While most emission tests have been to verify NOx, CO and overall hydrocarbon destruction, a number of tests have also measured the destruction of trace hydrocarbons, such as vinyl chloride. In all cases, McGill flare systems have met or exceeded the performance requirements and emission requirements.

NOx emissions typically range from 0.05 to 0.1 lb/MMBTU on landfill gas. The actual emission level is dependent upon the operating temperature, the CO_2 level, and the landfill gas itself, as high levels of nitrated compounds, such as acrylnitril or ammonia affect the formation of NOx. Lower operating temperature minimize the production of thermal NOx. The flame quenching effect of carbon dioxide in landfill gas also reduce thermal NOx.

CO emissions are very dependent upon the operating temperature and upon the amount of heavy trace hydrocarbons in the landfill gas. In most cases, operation above 1600°F with good mixing and residence time will minimize the CO emissions from even the worst landfill gas. Trace hydrocarbons, with higher molecular weights, also contribute disproportionately to their weight due to lack of complete combustion. CO emissions can range from 0.05 - 0.60 lb/MMBTU.

Emission tests for vinyl chloride have also been performed on McGill enclosed flares with excellent results. Operating at 1300°F to 1400°F with over 2 seconds residence, the 40 ft. high flares destroyed virtually 100% of the inlet vinyl chloride. Similar results were obtained for benzene and trichloroethane.

Landfill flares do not generate significant amounts of particulates and convert virtually all of the landfill gas H_2S to SO_2. Please note, however, that flares do not remove any of the particulates, SO_2 or HCl emissions that enter the flare in the landfill gas or air. A dusty day or nearby construction can give misleadingly high particulate values from dust in the combustion air. For particulates, sulfur and chlorine, landfill flares operate on a "mass in = mass out" basis.

SAFETY FEATURES

There are many features available to enhance the operation of a landfill combustion system. Some of the safety features are described below.

Flame Arrestor:

Three requirements must be met to create a flashback, an ignition source, a gas flow rate below the flashback velocity, and a flammable mixture in the gas stream. Although there is normally not enough oxygen in landfill gas to allow a flashback, a flame arrestor should be considered since abnormal conditions can occur. If there is an above average possibility a flashback can occur, the flame arrestor should have stainless steel internals. An automatic shutoff valve in the waste gas will stop the gas flow and keep the fire from burning on the outlet of the flame arrestor. If the possibility of a flashback is very unlikely, aluminum internals can be considered, but they must be periodically inspected to assure they have not been overheated. Also, in selecting a flame arrestor, an easily removeable design should be considered for ease of cleaning and inspection.

Purge Blower:

Enclosed combustors must be free of any flammable hydrocarbons before attempting to light. An automatic purge feature with a switch to prove that there is a purge flow rate should be considered for all enclosed combustors.

Flame Monitoring:

Thermocouples have proven to be cost effective and safe monitors for open, elevated flares. However, for the enclosed combustors, UV type flame detectors should be used. These give almost instantaneous detection of flame failure as compared to the delayed response typical with a thermocouple. This is important so the inlet valve can be shut before the vessel fills up with unburned gas. For safety, only the self checking type flame detectors should be used. Although rare, the other types can fail and still indicate there is a fire in the combustor.

Heat Shield:

The shell of an enclosed combustor typically operates between 250 and 350°F. For personnel protection, a heat shield should be provided up to a safe height.

Fail-Safe Valve:

For any type of flame failure, including a power outage, a fail safe inlet valve will insure the landfill gas is isolated from the combustor.

SUMMARY

The proper selection of landfill combustors depends upon the required design and operating objectives. Open flame flares provide good hydrocarbon destruction efficiencies at economical prices. Invisible flares enclose most or all of the flame and allow verifiable operating temperatures. The taller emission control enclosed combustors have increased mixing energy, residence time and operating temperature capabilities to meet increasingly stringent emission regulations.

The key point is to know and advise the flare designer of the specific emission requirements and operating expectations.

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"A Report on a Flare Efficiency Study", Chemical Manufacturer's Association, Washington, D.C., March, 1983.

Giles, David L., EnviroPro, "Landfill Gas Flare System Design Basis", March 13, 1989.

Young, John, "Incineration Equipment Selection", March 1 - 3, 1989.

sales3/354

ANALYSIS

DATE: 04/08/93	ANALYSIS TIME: 165	STREAM SEQUENCE: 1
TIME: 16:33	CYCLE TIME: 180	STREAM#: 1
ANALYZER#: 002903	MODE: RUN	CYCLE START TIME: 16:30

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	40.576	0.00	0.6166
OXYGEN	116	0.683	0.00	0.0075
NITROGEN	114	7.452	0.00	0.0721
METHANE	100	51.288	519.04	0.2841
TOTALS		100.000	519.04	0.9803

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 520.6
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 511.6
REAL SPECIFIC GRAVITY	= 0.9827
UNNORMALIZED TOTAL	= 98.17

ACTIVE ALARMS

NONE

April 1992

Compliance Emissions Test Report
Power Production Facility
Building A

SUMMARY OF RESULTS - GAS TURBINE NO. 3

	RUN 1	RUN 2	RUN 3	AVERAGE
SULFUR DIOXIDE				
CONCENTRATION (PPM)*	6.4	1.7	2.4	3.5
EMISSIONS (LBS/HR)	2.56	0.65	0.94	1.38
NITROGEN OXIDES				
CONCENTRATION (PPM)*	22.1	23.2	23.4	22.9
EMISSIONS (LBS/HR)	6.3	6.5	6.5	6.4

ALLOWABLE EMISSIONS	ppm*	lbs/hr
NITROGEN OXIDES	51.0	9.0
SULFUR DIOXIDE	32.0	25.93

* NOx and SO_2 Concentrations are corrected to 15% O_2 on a wet basis.

South Florida Environmental Services

Compliance Emissions Test Report
Power Production Facility
Building B

SUMMARY OF RESULTS - GAS TURBINE NO. 4

	RUN 1	RUN 2	RUN 3	AVERAGE
SULFUR DIOXIDE				
CONCENTRATION (PPM)*	1.2	3.0	1.7	2.0
EMISSIONS (LBS/HR)	0.44	1.19	0.66	0.76
NITROGEN OXIDES				
CONCENTRATION (PPM)*	22.9	23.4	23.7	23.3
EMISSIONS (LBS/HR)	6.3	6.6	6.5	6.5

ALLOWABLE EMISSIONS	ppm*	lbs/hr
NITROGEN OXIDES	51.0	9.0
SULFUR DIOXIDE	32.0	25.93

* NOx and SO_2 Concentrations are corrected to 15% O_2 on a wet basis.

South Florida Environmental Services

FLARE SYSTEM AIR PERMIT APPLICATION

GAS FLOW RATE AND EXIT VELOCITY

This analysis will assume constant maximum landfill gas flow rate.

Maximum landfill gas flow rate = 3,140 scfm

Maximum concentration of methane in landfill gas is 60%, 40% CO_2.

Calculate gas exit velocity:

Flare designed to achieve minimum of 98% destruction efficiency of total hydrocarbons in accordance with EPA criteria 40 CFR 60.18.

To achieve destruction efficiency, gas exit velocity at flare tip must be less than 60 ft./sec. with net heating value of gas maintained at 200 BTU/scfm or greater.

With methane content of 40% - 60%, the net gas heating value would be between 404-607 BTU/scfm.

Flare tip and tip velocity:
Assume tip temperature of 120°F and a gas flow of 3,140 scfm (maximum design capacity for flare).

Flow corrected for 120°F =

$$\left(3140 \text{ scfm}\right) \times \left(\frac{460 + 120}{520}\right) = 3502 \text{ ACFM}$$

$$\text{Flare tip velocity} = \frac{\text{actual flow}}{\text{tip cross-sectional area}}$$

$$= \frac{3502 \text{ ACFM}}{\dfrac{\pi \times 14^2 \text{ in.}}{4 \times 144 \dfrac{\text{in}^2}{\text{ft}^2}}} = 3278 \text{ fpm}$$

$$= \frac{3278 \text{ fpm}}{60 \dfrac{\text{sec}}{\text{min}}} = 55 \text{ ft/sec} < 60 \text{ ft/sec}$$

Utilization Rate:

CH_4 3140 scfm x 60/100 x 16 lb/lb mol x 1/359 lb mol/ft^3

x 60 min/hour = 5038 lbs/hr.

Florida Department of Environmental Regulation

Twin Towers Office Bldg. • 2600 Blair Stone Road • Tallahassee, Florida 32399-2400

Lawton Chiles, Governor

Virginia B. Wetherell, Secretary

CERTIFIED MAIL -- RETURN RECEIPT REQUESTED

February 26, 1993

Mr. James A. Waters
Group Vice President
Waste Management of North America
500 Cyprus Creek Road, Suite 300
Ft. Lauderdale, Florida 33309

Dear Mr. Waters:

Re: File No. AC13-218495
Medley Landfill Flare

This letter is in response to the comments made in Ms. Charlene Pisatowski's letter dated January 25, 1993, on the referenced facility source. Our review of the document, and attachments thereto, reveals the following items still need further clarification:

Gas Flow from Flare/Estimated Emissions.

Page 2 of the attachment to Ms. Pisatowski's letter contains the following equation to compute the volumetric flow rate of "air needed for combustion at 1400° F":

3140 scfm * .6 * 31.42 scfm (air)/scfm (CH_4)

Please provide the derivation and/or reference for the 31.42 factor utilized.

Also on page 2, the following table of "theoretical stack effluent at 1400° F combustion temperature" is displayed:

N_2 --> 75.0 %
O_2 --> 13.9 %
CO_2 --> 5.04 %
H_2O --> 6.045%

Please provide the derivation of these percentages.

The first paragraph on page 3 contains a table of "expected emissions", reproduced below:

NO_x --> 12 ppmv
CO --> 480 ppmv

Please provide the basis for these expected emissions.

It appears that the calculation on page 1 contains a typographical error, resulting in an erroneous "flare tip velocity" estimate. We believe the correct value is 3279 fpm. Please verify that this is the case.

We will continue processing your permit application when we receive a response to the above items. If you have any questions on this matter, please contact Thomas Cascio on 904-488-1344 or write to me at the above address.

Sincerely,

J. C. Brown, Jr., P.E.
Administrator
Permitting and Standards Section

cc: S. Brooks, SED
E. Anderson, DERM
H. Bush, Jr., P. E.
T. Cascio, BAR
M. Yon, BS&HW

W. Hanks, BAR
Charlene Pisatowski, Staff Engineer,
Central Disposal
3000 N. W. 48th Street
Pompano Beach, Florida
33073

Is your RETURN ADDRESS completed on the reverse side?

SENDER:
- Complete items 1 and/or 2 for additional services.
- Complete items 3, and 4a & b.
- Print your name and address on the reverse of this form so that we can return this card to you.
- Attach this form to the front of the mailpiece, or on the back if space does not permit.
- Write "Return Receipt Requested" on the mailpiece below the article number.
- The Return Receipt will show to whom the article was delivered and the date delivered.

I also wish to receive the following services (for an extra fee):

1. ☐ Addressee's Address
2. ☐ Restricted Delivery

Consult postmaster for fee.

3. Article Addressed to:

Mr. James A. Waters
Group Vice President
Waste Management of N. America
500 Cypre Creek Rd., Suite 300
Ft. Lauderdale, FL 33309

4a. Article Number
P 360 528 994

4b. Service Type
☐ Registered ☐ Insured
☒ Certified ☐ COD
☐ Express Mail ☐ Return Receipt for Merchandise

7. Date of Delivery

5. Signature (Addressee)
W. Viu

6. Signature (Agent)

8. Addressee's Address (Only if requested and fee is paid)

PS Form **3811**, December 1991 ☆U.S. GPO: 1992—323-402 **DOMESTIC RETURN RECEIPT**

Thank you for using Return Receipt Service.

P 360 528 994

Receipt for Certified Mail
No Insurance Coverage Provided
Do not use for International Mail
(See Reverse)

UNITED STATES POSTAL SERVICE

Sent to Mr. James A. Waters, Waste Mgt.	
Street and No. 500 Cypress Creek, Ste 300	
P.O., State and ZIP Code Ft. Lauderdale, FL 33309	
Postage	$
Certified Fee	
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt Showing to Whom & Date Delivered	
Return Receipt Showing to Whom, Date, and Addressee's Address	
TOTAL Postage & Fees	$
Postmark or Date Mailed: 3-1-93 Permit: AC 13-218495	

PS Form **3800**, June 1991

Central Disposal
3000 N.W. 48th Street
Pompano Beach, Florida 33073
305/977-9551

A Waste Management Company

Poster Polly - file a copy was Jam c copy

RECEIVED GPH 2/9

FEB 08 1993

Division of Air Resources Management

January 25,1993

Mr. John C. Brown, Jr.
Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Re: File No. AC13-218495
Medley Landfill Flare Application
Request for Additional Information

Dear Mr. Brown:

This letter is in response to the comments made in your memo dated December 22, 1992 requesting further information for the application to construct and operate a landfill gas flare at the Medley Landfill and Recycling Center in Medley, Florida.

The first comment requests clarification on the output gas flow from the well system. The comment refers to a 1026 scfm flow rate specified in Specific Condition No. 22 of the solid waste permit while our application refers to 3140 scfm flow rate. The 1026 scfm flow rate was an estmate specified in the Landfill Gas Management System Report submitted with the modification application to the solid waste permit. This report was included in Specific Condition No. 22 of the solid waste permit which approved the installation of the gas collection system. The report specifies the 1026 scfm flow rate as an estimate for the initial 48 gas extraction wells. The report also specifies an anticipated flow rate of 3194 scfm based on future expansion of the system. The 3140 scfm flow rate is the rated capacity of the flare. We would upscale the flare should future expansions of the system come close to approaching flare capacity. The system is permitted for a maximum of 3194 scfm, per the approved report. Please refer to Section 2.2 of the report previously submitted to you in reference to these flow rates. I have also enclosed this page of the report in this submittal. Please note that the average flow rate of 37.6 scfm you derived for the flow per well was based on data for an existing gas collection system which is utilized for a differnt purpose than the Medley Landfill collection system. The data is based on a system operated to recover as much gas as possible from the landfill avoiding instances of oxygen intrusion. This system is used to generate gas to power a Resource Recovery Facility which converts the gas to electricity. The vaccum applied to the wells is greater than the expected vaccum to be applied to the Medley collection system, thereby resulting in a smaller flow per well for the Medley system.

FLARE SYSTEM AIR PERMIT APPLICATION

GAS FLOW RATE AND EXIT VELOCITY

This analysis will assume constant maximum landfill gas flow rate.

Maximum landfill gas flow rate = 3,140 scfm

Maximum concentration of methane in landfill gas is 60%, 40% CO_2.

Calculate gas exit velocity:

Flare designed to achieve minimum of 98% destruction efficiency of total hydrocarbons in accordance with EPA criteria 40 CFR 60.18.

To achieve destruction efficiency, gas exit velocity at flare tip must be less than 60 ft./sec. with net heating value of gas maintained at 200 BTU/scfm or greater.

With methane content of 40% - 60%, the net gas heating value would be between 404-607 BTU/scfm.

Flare tip and tip velocity:
Assume tip temperature of 120°F and a gas flow of 3,140 scfm (maximum design capacity for flare).

Flow corrected for 120°F =

$$3140 \text{ scfm} + \frac{460 + 120}{520} = 3141 \text{ ACFM}$$

$$\text{Flare tip velocity} = \frac{\text{actual flow}}{\text{tip cross-sectional area}}$$

$$= \frac{3141 \text{ ACFM}}{\dfrac{\pi \times 14^2 \text{ in.}}{4 \times 144 \dfrac{\text{in}^2}{\text{ft}^2}}} = 2938 \text{ fpm}$$

$$= \frac{2938 \text{ fpm}}{60 \dfrac{\text{sec}}{\text{min}}} = 49 \text{ ft/sec} < 60 \text{ ft/sec}$$

Utilization Rate:

$CH_4 \rightarrow$ 3140 scfm x 60/100 x 16 lb/lb mol x 1/359 lb mol/ft^3

x 60 min/hour = 5038 lbs/hr.

$CO_2 \rightarrow$ 3140 scfm x 40/100 x 44 lb/lbmol x 1/359 lbmol/ft^3 x

60 min/hr = 9236 lbs/hr.

H_2S 3140 scfm x .0004/100 x 34 x 1/359 x 60 = .07 lbs/hr.=0.

TOTAL INPUT RATE = 5038 + 9236 + .07 = 14,274 lbs/hr.

Air needed for combustion at 1400°F

$$3140 \text{ scfm} \times 60\% \times 31.42 \ \frac{\text{scfm air}}{\text{scfm } CH_4} = 59{,}195 \text{ scfm.}$$

Total product flow = 3,140 scfm + 59,195 scfm = 62,335 scfm.

Combustion heat release:

3,140 scfm x 60/100 x 1,012 BTU/ft^3 CH^4 x 60 =

114,396,480 BTU/hr.

Theoretical stack effluent at 1400° F.

Combustion Temp:

$N_2 \rightarrow$ 75%
$O_2 \rightarrow$ 13.9%
$CO_2 \rightarrow$ 5.04%
$H_2O \rightarrow$ 6.045%

Stack Effluent by weight:

$N_2 \rightarrow$ 62,335 scfm x .75 x 28 lb/lbmol x 60 min/hr. x 1/359 lbmol/ft^3 = 218,781 lbs/hr.

$O_2 \rightarrow$ 62,335 scfm x .139 x 32 lb/lbmol x 60 x 1/359 = 46,339 lb/hr

$CO_2 \rightarrow$ 62,335 scfm x .0504 x 44 lb/lbmol x 60 x 1/359 = 23,103 lbs/hr.

$H_2O \rightarrow$ 62,335 scfm x .06045 x 18 lb/lbmol x 60 x 1/359 = 11,336 lbs/hr.

Product Weight:

218,781 + 46,339 + 23,103 + 11,336 = 299,559 lbs/hr.

Expected Emission:

NO_x → 12 PPMV
CO → 480 PPMV

NO_x $12/10^6$ x 62,335 scfm x 46 lb/lbmol x 1/359 x 60 = 5.75 lbs/hr.

CO $480/10^6$ x 62,335 x 28 lb/lbmol x 1/359 x 60 = 140 lbs/hr.

SO_4 mols in = mols out = $\frac{.07 \times 64}{34}$ = 0.13 lbs/hr.

Convert to Tons/Year:

N_2 - 218,781 lbs/hr x 24 hr/day x 365 days/year x 1 ton/2000 lbs = 958,261 tons/year.

O_2 - 46,339 lbs/hr x 24 x 365 x 1 ton/2000 lbs = 202,965 tons/year.

CO_2 - 23,103 lbs/hr x 24 x 365 x 1 ton/2000 lbs = 101,191 tons/year.

H_2O - 11,336 lbs/hr x 24 x 365 x 1 ton/2000 lbs = 2,069 tons/year.

NO_x - 5.75 lbs/hr. x 24 x 365 x 1 to/2000 lbs. = 25 tons/year.

CO - 140 lbs/hr x 24 x 365 x 1 ton/2000 lbs. = 613 tons/year.

SO_2 - .13 lbs/hr x 24 x 365 x 1 ton/2000 lbs. = .57 tons/year.

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

A. Raw Materials and Chemicals Used in your Process, if applicable:

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		
LANDFILL GAS	CH_4	60	}	
	CO_2	35	} 3140 scfm	
	H_2S	.004	}	

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): ______________________

2. Product Weight (lbs/hr): ______________________

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

Name of Contaminant	Emission[1] *		Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/yr	T/yr	
N_2	218,781	958.261			POTENTIAL NOT		
O_2	46,339	202,965			YET DETERMINED.		
CO_2	23,103	101,191			ACTUAL GAS FLOW RATE		
H_2O	11,336	2069			NECESSARY TO DETERMINE		
NO_x	5.75	25					
CO	140	613			ACTUAL EMISSIONS		
SO_4	.13	.57					

[1] See Section V, Item 2.

[2] Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3] Calculated from operating rate and applicable standard.

[4] Emission, if source operated without control (See Section V, Item 3).

* Theoretical gas flow rate used to determine these emissions.

** Not specified in F.A.C. 17-2.600 emission limiting and performance standards for a landfill gas flare.

There are a total of 7 engineered low points in the collection header system for the collection of condensate, which is generated by the cooling of the methane gas that occurs between the gas extraction well and blower flare station. The condensate that is removed from the collection system will be pumped directly to existing leachate collection manholes or to the leachate force main system and disposed of along with the landfill leachate.

Each gas extraction well is located and spaced according to a calculated zone of influence (ZOI). The ZOI defines an area from which gas can be extracted without inducing excessive air intrusion into the landfill. Each gas extraction well is connected via a lateral pipe to a main collection header.

The collection header is designed as a looped network to provide continuous removal of landfill gas in the event that a section of header becomes inoperative. Control valves are located throughout the collection header to allow for isolation of sections for monitoring and maintenance. The header is sloped to provide for gravity collection of condensate and prevent blockages caused by differential settlement. All anticipated current and future extracted gas volumes, velocities, and collection header pressure drops are accounted for in the sizing of the collection header.

The vacuum required to extract and transport the landfill gas is provided by a centrifugal blower. From the blower, the gas is delivered to the flare for thermal destruction.

2.2 Construction Phases

The Perimeter Well System will consist of a total of 48 gas extraction wells. The calculated flow rate from this system is estimated to be 1026 cfm. The anticipated condensate production during operation of the perimeter system is 1113 gal. per day. The anticipated closure date for Medley Landfill and Recycling Center is in the year 2003. Additional interior gas extraction wells may be installed in the future based on the anticipated final grades and gas production at closure. The anticipated gas extraction rate for the future landfill conditions is estimated to be 3194 cfm. This value was based on a gas production model (data sheet) developed with an

Central Disposal
3000 N.W. 48th Street
Pompano Beach, Florida 33073
305 977-9551

A Waste Management Company

January 25,1993

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FEB 0 5 1993
Division of Air
Resources Management

Tom - 2/5
Did you receive your copy of this? Please return to me for file - Patty

Mr. John C. Brown, Jr.
Florida Department of Environmental Re[illegible]
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Re: File No. AC13-218495
Medley Landfill Flare Application
Request for Additional Information

Dear Mr. Brown:

This letter is in response to the comments made in your memo dated December 22, 1992 requesting further information for the application to construct and operate a landfill gas flare at the Medley Landfill and Recycling Center in Medley, Florida.

The first comment requests clarification on the output gas flow from the well system. The comment refers to a 1026 scfm flow rate specified in Specific Condition No. 22 of the solid waste permit while our application refers to 3140 scfm flow rate. The 1026 scfm flow rate was an estmate specified in the Landfill Gas Management System Report submitted with the modification application to the solid waste permit. This report was included in Specific Condition No. 22 of the solid waste permit which approved the installation of the gas collection system.
The report specifies the 1026 scfm flow rate as an estimate for the initial 48 gas extraction wells. The report also specifies an anticipated flow rate of 3134 scfm based on future expansion of the system. The 3140 scfm flow rate is the rated capacity of the flare. We would upscale the flare should future expansions of the system come close to approaching flare capacity. The system is permitted for a maximum of 3194 scfm, per the approved report. Please refer to Section 2.2 of the report previously submitted to you in reference to these flow rates. I have also enclosed this page of the report in this submittal. Please note that the average flow rate of 37.6 scfm you derived for the flow per well was based on data for an existing gas collection system which is utilized for a differnt purpose than the Medley Landfill collection system. The data is based on a system operated to recover as much gas as possible from the landfill avoiding instances of oxygen intrusion. This system is used to generate gas to power a Resource Recovery Facility which converts the gas to electricity. The vaccum applied to the wells is greater than the expected vaccum to be applied to the Medley collection system, thereby resulting in a smaller flow per well for the Medley system. OK

FLARE SYSTEM AIR PERMIT APPLICATION

GAS FLOW RATE AND EXIT VELOCITY

This analysis will assume constant maximum landfill gas flow rate.

Maximum landfill gas flow rate = 3,140 scfm

Maximum concentration of methane in landfill gas is 60%, 40% CO_2.

Calculate gas exit velocity:

Flare designed to achieve minimum of 98% destruction efficiency of total hydrocarbons in accordance with EPA criteria 40 CFR 60.18.

To achieve destruction efficiency, gas exit velocity at flare tip must be less than 60 ft./sec. with net heating value of gas maintained at 200 BTU/scfm or greater.

With methane content of 40% - 60%, the net gas heating value would be between 404-607 BTU/scfm. 1010 x .4 = 404 BTU/FT³

Flare tip and tip velocity: 1010 x .6 = 606

Assume tip temperature of 120°F and a gas flow of 3,140 scfm (maximum design capacity for flare).

Flow corrected for 120°F =

$$3140 \text{ scfm} + \frac{460 + 120}{520} = 3141 \text{ ACFM}$$

60+460 = 520 °R ? $3140\left(\frac{580}{520}\right) = 3502.3$

Flare tip velocity = $\frac{\text{actual flow}}{\text{tip cross-sectional area}}$ $Q = AV$ $V = \frac{Q}{A}$

$$= \frac{\cancel{3141}\ 3502 \text{ ACFM}}{\frac{\pi \times 14^2 \text{ in.}}{4 \times 144 \frac{in^2}{ft^2}}} = \cancel{2938}\ 3279 \text{ fpm}$$

$$= \frac{\cancel{2938}\ 3279 \text{ fpm}}{60 \frac{sec}{min}} = \cancel{49}\ 54.65 \text{ ft/sec} < 60 \text{ ft/sec}$$

Utilization Rate:

CH_4 → 3140 scfm x 60/100 x 16 lb/lb mol x 1/359 lb mol/ft³

x 60 min/hour = 5038 lbs/hr. ✓

$$\frac{3.14 \times 14 \times 14}{4 \times 144} = 1.068$$

CO_2 → 3140 scfm x 40/100 x 44 lb/lbmol x 1/359 lbmol/ft^3 x
60 min/hr = 9236 lbs/hr.

H_2S 3140 scfm x .0004/100 x 34 x 1/359 x 60 = .07 lbs/hr.=0.

TOTAL INPUT RATE = 5038 + 9236 + .07 = 14,274 lbs/hr.

Air needed for combustion at 1400° F

3140 scfm x 60% x (31.42 scfm air / scfm CH_4) = 59,195 scfm.

Total product flow = 3,140 scfm (CH_4 + CO_2 + H_2S) + 59,195 scfm (AIR) = 62,335 scfm.

Combustion heat release:

3,140 scfm x 60/100 x 1,012 BTU/ft^3 CH^4 x 60 =
114,396,480 BTU/hr.

Theoretical stack effluent at 1400° F.

Combustion Temp:

N_2 → 75%
O_2 → 13.9%
CO_2 → 5.04%
H_2O → 6.045%
99.985 %

Stack Effluent by weight:

N_2 → 62,335 scfm x .75 x 28 lb/lbmol x 60 min/hr. x 1/359 lbmol/ft^3 = 218,781 lbs/hr.

O_2 → 62,335 scfm x .139 x 32 lb/lbmol x 60 x 1/359 = 46,339 lb/hr

CO_2 → 62,335 scfm x .0504 x 44 lb/lbmol x 60 x 1/359 = 23,103 lbs/hr.

H_2O → 62,335 scfm x .06045 x 18 lb/lbmol x 60 x 1/359 = 11,336 lbs/hr.

Product Weight:

218,781 + 46,339 + 23,103 + 11,336 = 299,559 lbs/hr.

SOURCES of % ?

Expected Emission:

NO_x → 12 PPMV — 12×10^{-6}
CO → 480 PPMV — 480×10^{-6}

NO_x $12/10^6$ x 62,335 scfm x 46 lb/lbmol x 1/359 x 60 = 5.75 lbs/hr.

CO $480/10^6$ x 62,335 x 28 lb/lbmol x 1/359 x 60 = 140 lbs/hr.

SO_4 mols in = mols out = $\frac{.07 \times 64}{34}$ = 0.13 lbs/hr.

Convert to Tons/Year:

N_2 - 218,781 lbs/hr x 24 hr/day x 365 days/year x 1 ton/2000 lbs = 958,261 tons/year.

O_2 - 46,339 lbs/hr x 24 x 365 x 1 ton/2000 lbs = 202,965 tons/year.

CO_2 - 23,103 lbs/hr x 24 x 365 x 1 ton/2000 lbs = 101,191 tons/year.

H_2O - 11,336 lbs/hr x 24 x 365 x 1 ton/2000 lbs = ~~2,069~~ 49,651 tons/year.

NO_x - 5.75 lbs/hr. x 24 x 365 x 1 to/2000 lbs. = 25 tons/year.

CO - 140 lbs/hr x 24 x 365 x 1 ton/2000 lbs. = 613 tons/year.

SO_2 - .13 lbs/hr x 24 x 365 x 1 ton/2000 lbs. = .57 tons/year.

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

A. Raw Materials and Chemicals Used in your Process, if applicable:

Description	Contaminants Type	Contaminants % Wt	Utilization Rate - lbs/hr	Relate to Flow Diagram
LANDFILL GAS	CH_4	60	3140 scfm	
	CO_2	35		
	H_2S	.004		

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): ________

2. Product Weight (lbs/hr): ________

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

Name of Contaminant	Emission[1] * Maximum lbs/hr	Emission[1] * Actual T/yr	Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission lbs/yr	Potential[4] Emission T/yr	Relate to Flow Diagram
N_2	218,781	958,261	✓		POTENTIAL NOT		
O_2	46,339	202,965	✓		YET DETERMINED.		
CO_2	23,103	101,191	✓		ACTUAL GAS FLOW RATE		
H_2O	11,336	2069	✓		NECESSARY TO DETERMINE		
NO_x	5.75	25	✓		ACTUAL		
CO	140	613	✓		EMISSIONS		
SO_4	.13	.57	✓				

[1]See Section V, Item 2.

[2]Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3]Calculated from operating rate and applicable standard.

[4]Emission, if source operated without control (See Section V, Item 3).

* Theoretical gas flow rate used to determine these emissions.

** Not specified in F.A.C. 17-2.600 emission limiting and performance standards for a landfill gas flare.