FILE COPY

ATMOSPHERIC EMISSIONS DURING DEMONSTRATION OF THE CLEAN SOIL PROCESS® OF THE NORWICH, NEW YORK MANUFACTURED GAS PLANT SITE

From:

NGE Enterprises, Inc.
c/o New York State Electric & Gas Corporation
4500 Vestal Parkway East • P.O. Box 5231-C
Binghamton, NY 13092-5231

Prepared by:

Atlantic Environmental Services, Inc.
188 Norwich Avenue • P.O. Box 297
Colchester, CT 06415

January 31, 1995

ATLANTIC CONFIDENTIAL

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

ATMOSPHERIC EMISSIONS DURING DEMONSTRATION OF THE CLEAN SOIL PROCESS®

1.0 BACKGROUND

To evaluate the effectiveness, efficiency, reliability, and costs of the Clean Soil Process® (CSP) for partial remediation of wastes at former manufactured gas plant (MGP) sites, CSP will be tested during an interim remedial measure (IRM) to be completed by the New York State Electric and Gas Corporation (NYSEG) at its former MGP site in Norwich, New York. The demonstration is being conducted by NGE Enterprises, Inc. (NGE), a subsidiary of NYSEG. The IRM will involve two fundamental operations: (1) removal of MGP wastes (excavation) from designated locations, and (2) treatment of the excavated materials via CSP at predetermined operating conditions developed during pilot studies. The objective of the IRM is to reduce contamination in the MGP wastes to comply with New York State guidance regarding soil cleanup objectives. After satisfactory processing, the treated material will be backfilled and eliminated from further remedial treatment.

The overall objective of the NGE evaluation is to quantify the operation of CSP to assess its viability/feasibility for use in association with a program of remedial co-burning of MGP wastes in utility boilers. In transferring MGP contaminants to fine coal particles by adsorption via CSP, the coal is enriched with the combustible substances. By removing volatile organics as a product of CSP, including benzene, the combustible product is expected to qualify as nonhazardous material. Two NYSEG power plants, the Jennison and Hickling stations, are equipped and permitted for co-burning MGP-waste materials. The demonstration, using wastes from the Norwich MGP site, will provide the following specific objectives:

(1) assessment of the CSP for commercial-scale applications;

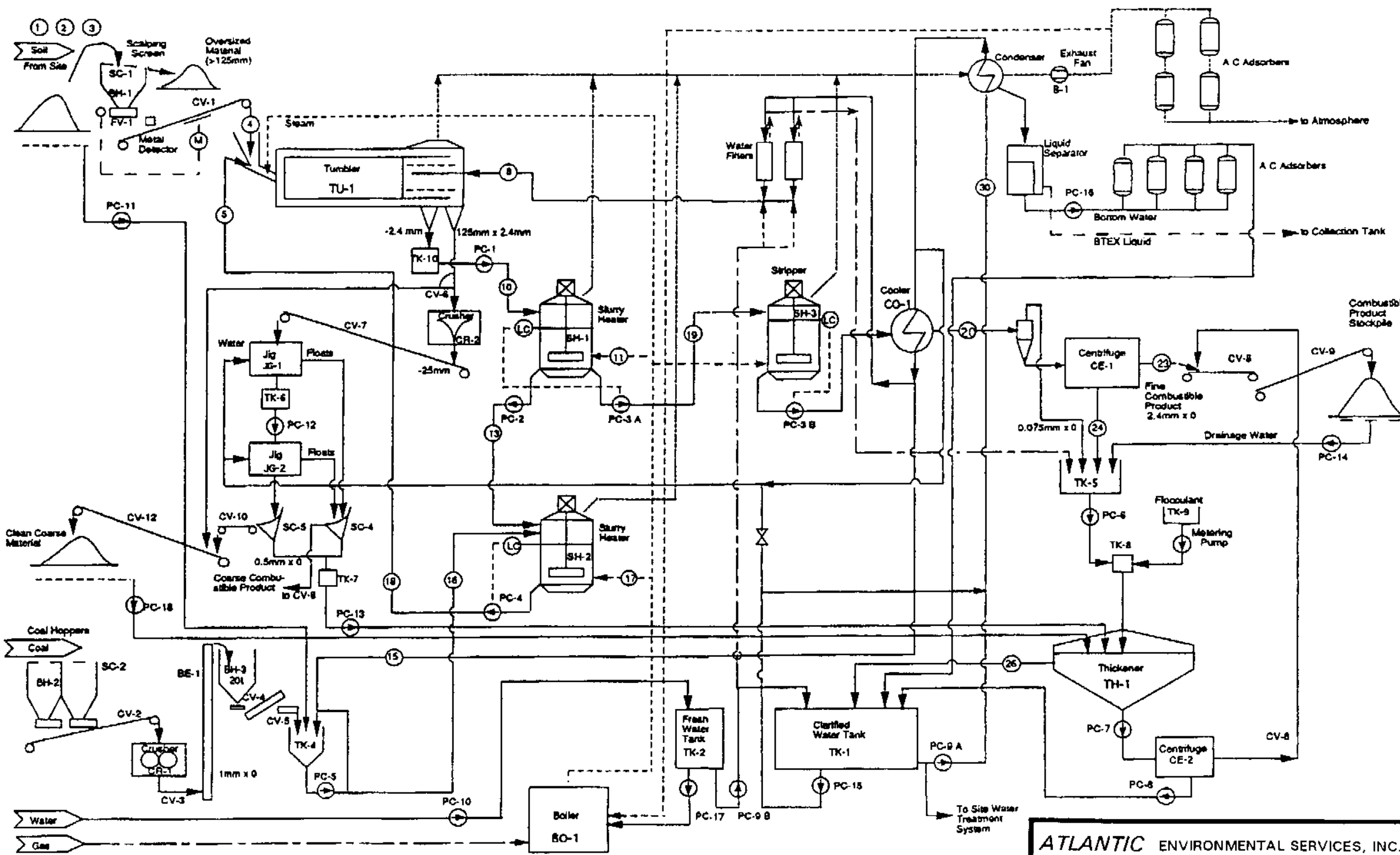
(2) comparison of the CSP treatment using results from different types of typical MGP wastes (e.g., relief holder and tar well contamination); and

(3) cost analysis.

The planned demonstration of the CSP involves several potential sources of atmospheric emissions:

- the Sprung™ structure, which will enclose portions of the operation (i.e., feed and output of the treated material);
- the CSP process downstream of the condenser (Figure 1-1); and
- a 200-hp boiler fueled by natural gas (Figure 1-1).

11/07/94 16:54 ALBERTA RESEARCH COUNCIL → 203 537 6347 NO.051 P002 11/07/94 16:55 ALBERTA RESEARCH COUNCIL → 203 537 6347 NO.051 P003



Flow Diagram of the Simplified Clean Soil Process.

(Nov. 3,1994)

CONFIDENTIAL

ATLANTIC ENVIRONMENTAL SERVICES, INC.
PROJECT NUMBER: 2051-01-02

FIGURE 1-1
PROCESS FLOW DIAGRAM
OF THE SIMPLIFIED
CLEAN SOIL PROCESS

NGE ENTERPRISES, INC.

2.0 SPRUNG™ STRUCTURE

The Sprung™ structure is not considered an emissions source subject to permitting, because it will be open with simple ventilation through open doors. No air treatment system is contemplated for organic emissions. Two relatively small stockpiles (80 tons each) of untreated material will be created and depleted simultaneously within the structure during operation of CSP. As one stockpile is used to feed CSP, a second small stockpile will be created for subsequent feed to CSP. The staging stockpile of covered, excavated material located outside the Sprung™ structure will supply material for the 80 ton stockpiles.

3.0 CLEAN SOIL PROCESS® (CSP)

A principal function of CSP is the collection and management of the volatile hydrocarbons typically associated with MGP waste soils, i.e., benzene, toluene, ethylbenzene, and xylenes (BTEX). Within CSP, BTEX will be volatilized, captured, and condensed, resulting in a liquid solvent product. CSP is a closed system. Air flow entering the system is calculated based on the assumption of 25 percent pore space in the material to be treated and the rate of operation for the exhaust fan which draws vapors to the condenser. The range of air flow at a feed rate of 10 metric tons per hour is from 2 to 20 m^3/hr.

The attached flow diagram of the Simplified Clean Soil Process (Figure 1-1) depicts the operation of CSP planned for the Norwich demonstration. Condensation of the captured volatiles, largely benzene, toluene, ethylbenzene and xylenes (BTEX), will minimize the amount of potential air emissions from the system. The capacity of the condenser will be 2.5 tons per hour. The operational efficiency of the condenser included with CSP is expected to be relatively high, but will vary with flow rate and BTEX concentration. Some residual BTEX vapor is expected downstream of the condenser, but it will be contained and managed in two ways: (1) recycling for combustion or (2) filtration through activated carbon. Benzene is expected to be the principal gaseous residual downstream of the condenser, because it is the most volatile of BTEX compounds.

During the demonstration, CSP will be operated in two modes to manage the potential emissions of residual organic volatiles. The emissions will be either:

- vented to the atmosphere after activated carbon filtration; or
- recycled to the boiler.

The solvent product will be handled by a reclamation contractor or manufacturer. Based on calculations shown in Appendix A, the estimated volume of solvent product will range from approximately 2 to 4 gallons per hour of operation at a feed rate of 10 metric tons per hour. The average detected concentrations of BTEX in the areas to be excavated during the IRM are the basis for this range:

Benzene	321 mg/kg
Toluene	471 mg/kg
Ethylbenzene	118 mg/kg
Xylene	498 mg/kg

From measurements of BTEX in soils to be used for the demonstration (Task II Site Investigation), the composition of the solvent product is expected to consist of chiefly toluene and xylenes.

4.0 BOILER

A boiler will generate steam during operation of CSP. During boiler output from 25 to 100 percent, it will be fueled with natural gas at an estimated range of 55 to 220 m^3/hr. and the combustion air demand will range from 579 to 2,317 m^3/hr. Because the unit uses natural gas as fuel, no permit is needed to operate it (6 NYCRR Part 201.6). The estimated maximum heat load resulting from the introduction of benzene to the boiler is 349,000 BTU/hr. (0.35 MBTU/hr.), as shown below.

Benzene High Heat Value = 18,188 BTU/lb = 3,687.5 BTU/ft

Assuming 20 m^3/hr of air, mass flow of benzene = 8.71 Kg/hr (2,205 lb/Kg) = 19.205 lb/hr.

Benzene Heat Load = (19.205 lb/hr.)(18,188 BTU/lb)
= 349,000 BTU/hr.
= 0.35 MBTU/hr.

5.0 EMISSIONS CONTROL

5.1 Atmospheric Venting through Activated Carbon Filters

The activated carbon filter system (Figure 1-1) is designed to work both sequentially and in parallel. Any residual vapor would pass through two pairs of filters before exiting to the atmosphere. A photoionization detector between the first and second pairs would detect breakthrough of the first pair should that occur before a scheduled substitution of fresh carbon canisters. The substitution sequence would remove the first pair of canisters and move the second pair into their place. Two fresh canisters would be installed at the second pair positions.

Information and calculations regarding the operation of the activated carbon filter system are provided in Form 76-19-3 for Process, Exhaust or Ventilation System (Appendix B).

5.2 Recycling

While operating CSP when recycling vapor to the boiler, an estimated maximum load of 8.71 kg/hr of residual benzene would be fed to the boiler combustion chamber with air flow from the system condenser. Because air introduced to the system will be limited to pore spaces in treated material, the air flow from the condenser will be relatively low; an estimated 2 to 20 m^3/hr. is estimated based on an assumed 25 percent pore space. The combustion air demand far exceeds the flow from the condenser as shown in Appendix C.

Information and calculations regarding the operation of the boiler during the recycling mode are provided in Form 76-19-2 for Stationary Combustion Installation (Appendix C).

APPENDIX A

VOLUME ESTIMATE FOR CONDENSED BTEX

VOLUME ESTIMATE FOR CONDENSED BTEX

Method

The volume of benzene, toluene, ethylbenzene, and xylene condensed and recovered by the Clean Soil Process® (CSP) was determined by estimating the mass flow rate of the compounds volatilized from the soil and then estimating the mass of compounds that pass through the condenser and remain in the vapor phase. The mass of compounds that pass through the condenser and remain in the vapor phase were determined to estimate potential vapor emissions from CSP (Appendix B). This calculation was based on the worst case assumption that the concentrations of BTEX are such that saturated conditions exist for each compound. This assumption is verified in the following calculations by determining the partial pressure of each compound at maximum and minimum soil concentrations (Phase III Investigation) and comparing the partial pressure to the vapor pressure of the compound at the condenser conditions. The partial pressure of each compound is a function of the compound's concentration in the air stream and the pressure in the condenser.

mt(kg/hr) = [Cs(mg/kg) x ms (kg/hr)]/1,000,000 (mg/kg)

where:

mt	=	total mass loading of compound
Cs	=	concentration of compound in soil
ms	=	mass loading of soil = 10,000 kg/hr

Ca($mg/m^{3)}$ = [Cs(mg/kg) x ms(kg/hr)]/Qa(m^3/hr)

where:

Ca	=	concentration of compound in the air stream to condenser
Cs	=	concentration of compound in soil
ms	=	mass loading of soil = 10,000 kg/hr
Qa	=	volumetric flow rate of air through system

Pi(psi) = [Ca(ppm) x Patm (psi)]/1,000,000

where

Pi	=	partial pressure of the compound
Ca	=	concentration of compound in the air stream to condenser
Patm	=	pressure in the condenser = 14.7 psi

Note: if Pi > vapor pressure (Pv), then saturated conditions exist
if Pi < Pv, then no condensation occurs for that specific compound

mc(kg/hr) = mt(kg/hr) - ma(kg/hr)

where

mc	=	mass of compound condensed in condenser
mt	=	total mass loading of compound
ma	=	mass of compound passed through condenser at saturated conditions

APPENDIX A

Input Parameters

	Cs (max) (mg/kg)	Cs(min) (mg/kg)	Cs(Avg)	(mg/m3)/ppm	Pv @ 25C (psi)	ma (kg/hr) @ Qa=2 m3/hr	ma (kg/hr) @ Qa = 20 m3/hr
Benzene	1250	0.002	321	3.25	1.84	0.87	8.71
Toluene	2000	0.002	471	3.83	0.55	0.3	3.04
Ethylbenzene	290	0.001	118	4.41	0.18	0.11	1.13
Xylenes	1600	0.005	498	4.41	0.13	0.09	0.85

RESULTS

Maximum soil concentrations and Qa = 2 m3/hr

	mt (kg/hr)	Ca (mg/m3)		Ca (ppm)	Pi (atm)	mc (kg/hr)	Vc (liters/hr)
Benzene	12.5	6.25E+06		1.92E+06	28.27	11.63	13.27
Toluene	20	1.00E+07		2.61E+06	38.38	19.7	22.72
Ethylbenzene	2.9	1.45E+06		3.29E+05	4.83	2.79	3.22
Xylenes	16	8.00E+06		1.81E+06	26.67	15.91	18.29
					Totals	**50.03**	**57.50**
						gal/hour	**15.19**

Maximum soil concentrations and Qa = 20 m3/hr

	mt (kg/hr)	Ca (mg/m3)		Ca (ppm)	Pi (atm)	mc (kg/hr)	Vc (liters/hr)
Benzene	12.5	6.25E+05		1.92E+05	2.83	3.79	4.32
Toluene	20	1.00E+06		2.61E+05	3.84	16.96	19.56
Ethylbenzene	2.9	1.45E+05		3.29E+04	0.48	1.77	2.04
Xylenes	16	8.00E+05		1.81E+05	2.67	15.15	17.41
					Totals	**37.67**	**43.34**
						gal/hour	**11.45**

Minimum soil concentrations and Qa = 2 m3/hr or 20 m3/hr

	mt (kg/hr)	Ca (mg/m3)		Ca (ppm)	Pi (atm)	mc (kg/hr)	Vc (liters/hr)
Benzene	0.00002	1.00E+01		3.08E+00	4.52E-05	0	0
Toluene	0.00002	1.00E+01		2.61E+00	3.84E-05	0	0
Ethylbenzene	0.00001	5.00E+00		1.13E+00	1.67E-05	0	0
Xylenes	0.00005	2.50E+01		5.67E+00	8.33E-05	0	0
					Totals	**0**	**0**

Average soil concentrations and Qa = 2 m3/hr

	mt (kg/hr)	Ca (mg/m3)		Ca (ppm)	Pi (atm)	mc (kg/hr)	Vc (liters/hr)
Benzene	3.21	1.61E+06		4.94E+05	7.26	2.34	2.67
Toluene	4.71	2.36E+06		6.15E+05	9.04	4.41	5.09
Ethylbenzene	1.18	5.90E+05		1.34E+05	1.97	1.07	1.23
Xylenes	4.98	2.49E+06		5.65E+05	8.30	4.89	5.62
					Totals	**12.71**	**14.61**
						gal/hour	**3.86**

Average soil concentrations and Qa = 20 m3/hr

	mt (kg/hr)	Ca (mg/m3)		Ca (ppm)	Pi (atm)	mc (kg/hr)	Vc (liters/hr)
Benzene	3.21	1.61E+06		4.94E+04	0.73		
Toluene	4.71	2.36E+06		6.15E+04	0.90	1.67	1.93
Ethylbenzene	1.18	5.90E+05		1.34E+04	0.20	0.05	0.06
Xylenes	4.98	2.49E+06		5.65E+04	0.83	4.13	4.75
					Totals	**5.85**	**6.73**
						gal/hour	**1.78**

Note:
For the purposes of this calculation, the maximum concentration = 50% of the maximum measured concentrations in the soil from areas to be excavated. Average concentration = mean of detected concentrations in areas to be excavated.

APPENDIX B

FORM 76-19-3 FOR PROCESS, EXHAUST, OR VENTILATION SYSTEM

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

COPIES: WHITE - ORIGINAL; GREEN - DIVISON OF AIR; WHITE - REGIONAL OFFICE; WHITE - FIELD REP; YELLOW - APPLICANT

OP | LOCATION | FACILITY | EMISSION POINT

A ADD / C CHANGE / D DELETE

READ INSTRUCTIONS CONTAINED IN FORM 76-11-12 BEFORE ANSWERING ANY QUESTION

PROCESS, EXHAUST OR VENTILATION SYSTEM

APPLICATION FOR PERMIT TO CONSTRUCT OR CERTIFICATE TO OPERATE

SECTION A

1 NAME OF OWNER / FIRM: THERMO DESIGN ENGINEERING LTD.
2 NUMBER AND STREET ADDRESS: 1624 70TH AVENUE, MAPLERIDGE INDUSTRIAL PARK
3 CITY - TOWN - VILLAGE: EDMONTON
4 STATE: ALBERTA CANADA
5 ZIP: T6P 1P5
6 OWNER CLASSIFICATION: A [X] COMMERCIAL; B [ ] INDUSTRIAL; C [ ] UTILITY; D [ ] FEDERAL; E [ ] STATE; F [ ] MUNICIPAL; G [ ] EDUC INST; H [ ] HOSPITAL; [ ] RESIDENTIAL; [ ] OTHER
7 NAME & TITLE OF OWNERS REPRESENTATIVE: TONY ROJEK, VICE PRES. ENGINEERING
8 TELEPHONE: 403-440 6064
9 NAME OF AUTHORIZED AGENT: NGE ENTERPRISES, INC.
10 TELEPHONE: (607) 762-4040
11 NUMBER AND STREET ADDRESS: 4500 VESTAL PARKWAY EAST, P.O. BOX 5231-C
12 CITY - TOWN - VILLAGE: BINGHAMTON
13 STATE: NY
14 ZIP: 13902-5231
15 NAME OF P.E. OR ARCHITECT PREPARING APPLICATION: PAUL BURGESS
16 N.Y.S. P.E. OR ARCHITECT LICENSE NO: 067038
17 TELEPHONE: (203) 537-0751
18 SIGNATURE OF OWNERS REPRESENTATIVE OR AGENT WHEN APPLYING FOR A PERMIT TO CONSTRUCT:
19 FACILITY NAME (IF DIFFERENT FROM OWNER - FIRM): SIMPLIFIES CLEAN SOIL PROCESS(CSP)
20 FACILITY LOCATION (NUMBER AND STREET ADDRESS): MGP SITE
21 CITY - TOWN - VILLAGE: NORWICH, NEW YORK
22 ZIP:
23 BUILDING NAME OR NUMBER:
24 FLOOR NAME OR NUMBER:
25 START UP DATE: 4 / 95 (MO / YR)
26 DRAWING NUMBERS OF PLANS SUBMITTED:
27 PERMIT TO CONSTRUCT: A [X] NEW SOURCE TEMP.; B [ ] MODIFICATION
28 CERTIFICATE TO OPERATE: A [ ] NEW SOURCE; C [ ] EXISTING SOURCE; B [ ] MODIFICATION

SECTION B

29 EMISSION POINT ID	30 GROUND ELEVATION (FT)	31 HEIGHT ABOVE STRUCTURES (FT)	32 STACK HEIGHT (FT)	33 INSIDE DIMENSIONS (IN)	34 EXIT TEMP (°F)	35 EXIT VELOCITY (FT/SEC)	36 EXIT FLOW RATE (ACFM)	37 SOURCE CODE	38 HRS/DAY	39 DAYS/YR	40 OPERATION BY SEASON (Winter, Spring, Summer, Fall)
1	1100								10	20	9 9

SECTION C

41 DESCRIBE PROCESS OR UNIT:
EXPERIMENTAL METHOD TO CLEAN SOILS CONTAMINATED WITH HYDROCARBONS BY MIXING WITH HEATED (80-99C) SLURRY OF FINE COAL & WATER; VOLATILIZE THEN CONDENSE BENZENE, TOLUENE, ETHYLBENZENE AND XYLENES; HANDLE RESIDUAL BENZENE VAPOR BY VENTING THRU ACTIVATED CARBON FILTERS OR DIVERTING FOR COMBUSTION IN BOILER, CONDENSED SOLVENTS HANDLED AS A PRODUCT.

SECTION D

EMISSION CONTROL EQUIPMENT ID	CONTROL TYPE	MANUFACTURER'S NAME AND MODEL NUMBER	DISPOSAL METHOD	DATE INSTALLED MONTH / YEAR	USEFUL LIFE
1	20		9	/	
2	17	CALGON		/	6-72 HRS.

SECTION E

CALCULATIONS

SEE ATTACHMENTS A, B AND C.

SECTION F

CONTAMINANT NAME	CAS NUMBER	INPUT OR PRODUCTION	UNIT	ENV RATING	EMISSIONS ACTUAL	UNIT	HOW DET	PERMISSIBLE	CONTROL EFFIC'CY	HOURLY EMISSIONS (LBS/HR) ERP	HOURLY ACTUAL	ANNUAL EMISSIONS (LBS/YR) ACTUAL	ANNUAL PERMISSIBLE
BENZENE	71-43-2		1			1	9						
TOLUENE	108-88-3		1			1	9						
ETHYL BENZENE	100-41-4		1			1	9						
XYLENES	1330-20-7		1			1	9						

SECTION G

SOLID FUEL TYPE	TONS/YR	% S	LIQUID FUEL TYPE	THOUSANDS OF GALLONS/YR	% S	GAS TYPE	THOUSANDS OF CF/YR	BTU/CF	APPLICABLE RULE	APPLICABLE RULE
						52	APPROX. 100,000			

Upon completion of construction sign the statement listed below and forward to the appropriate field representative.

THE PROCESS, EXHAUST OR VENTILATION SYSTEM HAS BEEN CONSTRUCTED AND WILL BE OPERATED IN ACCORDANCE WITH STATED SPECIFICATIONS AND IN CONFORMANCE WITH ALL PROVISIONS OF EXISTING REGULATIONS

155 SIGNATURE OF AUTHORIZED REPRESENTATIVE OF OWNER / DATE

AGENCY USE ONLY

156 LOCATION CODE | 157 FACILITY ID NO | 158 UTM E | 159 UTM N | 160 ID NUMBER | 161 DATE APPL RECEIVED | 162 DATE APPL REVIEWED | 163 REVIEWED BY

PERMIT TO CONSTRUCT

164 DATE ISSUED | 165 EXPIRATION DATE | 166 SIGNATURE OF APPROVAL | 167 FEE

168
1. DEVIATION FROM APPROVED APPLICATION SHALL VOID THIS PERMIT
2. THIS IS NOT A CERTIFICATE TO OPERATE
3. TESTS AND/OR ADDITIONAL EMISSION CONTROL EQUIPMENT MAY BE REQUIRED PRIOR TO THE ISSUANCE OF A CERTIFICATE TO OPERATE

CERTIFICATE TO OPERATE

169 DATE ISSUED | 170 EXPIRATION DATE | 171 SIGNATURE OF APPROVAL | 172 FEE

173
1 [ ] INSPECTED BY ____ DATE ____
2 [ ] INSPECTION DISCLOSED DIFFERENCES AS BUILT VS PERMIT. CHANGES INDICATED ON FORM
3 [ ] ISSUE CERTIFICATE TO OPERATE FOR SOURCE AS BUILT
4 [ ] APPLICATION FOR C TO O DENIED ____ DATE ____ TITLE

174 INFORMATION:

ATTACHMENT A

The rationale for the approach applied to determine benzene stream exiting from the condenser is as follows

* According to Dalton's Law (at saturation conditions) gas leaving the condenser will contain

$$V_{benzene} = P_{benz}/P_{atmospheric} = 12.7/101.3 \times 100\% = 12.5\%$$

$P_{benz.}$ - partial pressure for benzene

12.5 % (by volume) of benzene vapours.

** Molar mass of benzene ($C_6 H_6$) is 78 g/mole

1 kg of benzene contains 1000g/78g = 12.8 moles/kg
and 1 mole of any gas occupies 22.4 liters (Avogadro's Law)

so 1kg of benzene (under standard conditions) occupies

$$V = 12.8 \times 22.4 = 287 \text{ liters/kg}$$

***The amount of benzene (at saturation conditions) will depend the flow rate of gas exiting the condenser and will be

For 2 m^3/h flow rate

$$V_B = 2.0 \times 12.5\%/100\% = 0.25 \ m^3 \ (250 \text{ liters})/hr.$$

or 250/287 = 0.87 kg/hr.

Following that rule the data in Table 1 were obtained

Table 1

Total gas flow	m^3/h	2	12	20	23
Benzene stream	m^3/h	0.25	1.50	2.50	2.87
	kg/h	0.87	5.23	8.71	10.0

Attachment H

ATLANTIC ENVIRONMENTAL SERVICES, INC. COLCHESTER, CT

BY KS DATE 12/12/94 SUBJECT CLEAN SOIL PROCESS CONDENSER SHEET NO. 2 OF 5

CHKD. BY ____ DATE ____ JOB NO. 2051-01-02

ACTUAL WORSE CASE BENZENE LOADING BASED ON SOIL CONCENTRATION

Benzene Soil Concentration = 2500 mg/kg
SOIL LOADING RATE = 10,000 kg/hr
WORSE CASE BENZENE FLOW TO CONDENSER = 25 kg/hr

∴ REGARDLESS OF AIR FLOW RATE BENZENE CONCENTRATION EXITING CONDENSER COULD NEVER EXCEED 25 Kg/hr. BASED ON WORSE CASE SOIL DATA.

ADDITIONALLY IF THE BENZENE LOAD TO SYSTEM IS BELOW SATURATION THE MASS LEAVING THE CONDENSER WILL BE LOWER.

WORSE CASE TOLUENE AIR STREAM EMISSIONS FROM THE CONDENSER

NOTE: CALCULATIONS BASED ON VENDORS APPROACH FOR BENZENE VAPOUR. CALCULATIONS AT SATURATION CONDITIONS

TOLUENE VAPOR PRESSURE: $P_V = 0.55$ lb/in² @ 25 °C

- According to Daltons Law (at saturation conditions):

$$\frac{V_{toluene}}{V_{total}} = \frac{P_V}{P_{atmospheric}} = \frac{0.55 \text{ lb/in}^2}{14.7 \text{ lb/in}^2} = 0.037$$

∴ gas leaving the condenser will contain 3.7% Toluene by volume

- Molar mass of Toluene = 92.14 g/mole

for 1 kg of toluene: $\left(\frac{1000\,g}{kg}\right)\left(\frac{1\,mole}{92.14\,g}\right) = 10.85 \frac{mole}{kg}$

1 mole gas/22.4 liters ∴ $\upsilon_{toluene} = \left(10.85 \frac{mole}{kg}\right)\left(22.4 \frac{liters}{mole}\right) = 243 \frac{liters}{kg}$

- The amount of Toluene (at saturation conditions) will depend on the flow rate: V_{total}

$$V_{toluene} = V_{total}\,(.037)$$

@ $V_{total} = 20$ m³/hr

$V_{toluene} = 0.74$ m³/hr = 740 liters/hr

$$\text{Mass toluene} = \frac{V_{toluene}}{\upsilon_{toluene}} = \frac{740 \text{ liters/hr}}{243 \text{ liters/kg}} = 3.04 \text{ kg/hr}$$

WORSE CASE ETHYLBENZENE EMISSIONS FROM THE CONDENSER

NOTE: CALCULATIONS BASED ON VENDOR APPROACH FOR BENZENE CALCULATIONS AT SATURATED CONDITIONS

Ethylbenzene Vapor Pressure: $P_V = 0.18$ lb/in² @ 25 °C

- According to Daltons Law (at saturation conditions):

$$\frac{V_{EB}}{V_{total}} = \frac{P_V}{P_{atm}} = \frac{0.18}{14.7} = 0.012$$

∴ gas leaving the condenser will contain 1.2% ethylbenzene by volume

- molar mass of ethylbenzene = 106.17 g/mole

∴ 9.42 moles/kg

$$V_{ethylbenzene} = (9.42 \text{ moles/kg})(22.4 \text{ liters/mole}) = 211 \text{ liters/kg}$$

- The amount of ethylbenzene at saturation conditions will depend on the flow rate V_{total}

@ V_{total} = 20 m³/hour

$$V_{ethylbenzene} = (20 \text{ m}^3/\text{hr})(0.012) = 0.24 \text{ m}^3/\text{hr} = \underline{240 \text{ Liters/hr}}$$

$$\text{Mass of Ethylbenzene} = \frac{240 \text{ liters/hr}}{211 \text{ liters/kg}} = \underline{1.13 \text{ kg/hr}}$$

Attachment A

ATLANTIC ENVIRONMENTAL SERVICES, INC. COLCHESTER, CT

BY KES DATE 12/22/14 SUBJECT Clean soil Process — Condenser Performance SHEET NO. 5 OF 5

CHKD. BY AH DATE JOB NO. 2251-01-02

WORSE CASE XYLENE EMISSIONS FROM THE CONDENSER

NOTE: CALCULATIONS BASED ON VENDOR APPROACH FOR BENZENE CALCULATIONS AT SATURATED CONDITIONS

- XYLENE Vapor Pressure: $P_v = 0.13$ lb/in² @ 25 °C
- According to Daltons Law (at saturation conditions):

$$\frac{V_{xy}}{V_{total}} = \frac{P_v}{P_{atm}} = \frac{0.13}{14.7} = 0.009$$

∴ gas leaving the condenser will contain 0.9% XYLENE by volume

- molar mass of XYLENE = 106.17 g/mole

∴ 9.42 moles/kg

$$V_{XYLENE} = \left(9.42 \text{ moles/kg}\right)\left(22.4 \frac{\text{liters}}{\text{mole}}\right) = 211 \frac{\text{liters}}{\text{kg}}$$

- The amount of xylene at saturation conditions will depend on the flow rate V_{total}

@ V_{total} = 20 m³/hour

$$V_{xylene} = (20 \text{ m}^3/\text{hr})(0.009) = 0.18 \text{ m}^3/\text{hr} = \underline{180 \text{ liters/hr}}$$

$$\text{Mass of Xylene} = \frac{180 \text{ liters/hr}}{211 \text{ liters/kg}} = \underline{0.85 \text{ kg/hr}}$$

Attachment B

ATLANTIC ENVIRONMENTAL SERVICES, INC. COLCHESTER, CT

BY KES DATE 12/22/94 SUBJECT Clean Soils Process / Carbon Loading SHEET NO. 1 OF 1
CHKD. BY ____ DATE ____ JOB NO. 2051-01-02

- ASSUME FLOW RATE THROUGH SYSTEM = 20 m^3/hr
- CARBON LOADING CAPACITIES FROM CALGON CO.
- TWO 90 Kg carbon canisters will be used (total 180 kg)

BENZENE

concentration @ 20 m^3/hr from condenser = 0.43 kg/m^3

$\dot{m}$ = 8.71 kg/hr

Carbon Capacity = 0.35 kg benzene / kg carbon

$$\text{CARBON LIFE} = \frac{(0.35)(180 \text{ kg carbon})}{8.71 \frac{\text{kg benzene}}{hr}} = \underline{7.2 \text{ hours}}$$

TOLUENE

CONCENTRATION @ 20 m^3/hr = 0.152 kg/m^3

$\dot{m}$ = 3.04 kg/hr

Carbon Capacity = 0.35 kg toluene / kg carbon

$$\text{carbon LIFE} = \frac{(0.35)(180 \text{ kg carbon})}{3.04 \frac{\text{kg toluene}}{hr}} = \underline{20.7 \text{ hours}}$$

The carbon capacities for ethylbenzene and xylene are higher and the concentrations and mass loadings are lower. Therefore, the carbon life is significantly longer when evaluating for these compounds and benzene is still worse case.

ATTACHMENT C

Exhaust Analysis Results

Input Data Summary

Boiler Size, hp:	200
Rated Input, Btu/hr:	8,388,750
Fuel Type:	Natural Gas
Boiler Type:	Steam
Steam Pressure, psig:	10
Stack Diameter, in:	16

Exhaust Data Summary

	Input (percent)			
	25%	50%	75%	100%
Input				
Horsepower	50	100	150	200
MM Btu/hr	2.09	4.18	6.28	8.37
Temperature				
Degrees, F	260	290	310	325
Exhaust Flow				
ACFM	656	1,154	1,777	2,415
SCFM	483	816	1,224	1,831
lb/hr	2,172	3,669	5,503	7,338
Exhaust Velocity				
ft/sec	7.8	13.8	21.2	28.8
ft/min	469.5	826.3	1,272.5	1,729.7

ATTACHMENT C

BOILER HP	200
RATINGS - SEA LEVEL TO 5000 FT	
Rated Cap. Btu Output (1000 B tu/h)	6895
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY	
Light Oil	-
Heavy Oil	-
Gas MBtu - Natural Gas	8970
POWER REQUIREMENTS - SEA LEVEL TO 3000 FT, 60 HZ	
Blower Motor Hp (except gas)	-
Gas Models (only)	10
Oil Pump Motor, Hp No. 2 Oil	1/2
Oil Pump Motor, Hp. No. 6 Oil	1/2
Oil Heaters NW No. 6 Oil	5
Air Compressor Motor Hp (Oil Mixing Only)	Air Compressor Belt-Driven From Blower Motor

APPENDIX C

FORM 76-19-2 FOR STATIONARY COMBUSTION INSTALLATION

ATTACHMENT C

Estimated Emission Levels
Boiler Model: CB700-200-15
Fuel: Natural Gas

Emission Levels

Pollutant	lb/MMBTU	lb/hr	tons/year
CO	0.15	1.26	5.50
NOx	0.12	1.00	4.40
SOx	0.001	0.01	0.04
HC	0.016	0.13	0.59
PM	0.01	0.08	0.37

Notes:
1. The emission factors in lb/MMBTU are based on the evaluation of laboratory and field test data.
2. The hourly emission rates are based on the maximum rated capacity of the boiler (8,369 MMBTU/hr).
3. The annual emission levels in tons/year are based on the boiler firing 24 hours per day 365 per year.

OP | LOCATION | FACILITY | EMISSION POINT | C

A ADD / C CHANGE / D DELETE

READ INSTRUCTIONS CONTAINED IN FORM 76-11-4 BEFORE ANSWERING ANY QUESTION

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

COPIES
WHITE - ORIGINAL
BLUE - DIVISON OF AIR
WHITE - REGIONAL OFFICE
WHITE - FIELD REP
YELLOW - APPLICANT

STATIONARY COMBUSTION INSTALLATION

APPLICATION FOR PERMIT TO CONSTRUCT OR CERTIFICATE TO OPERATE

SECTION A

1. NAME OF OWNER / FIRM: THERMO DESIGN ENGINEERING LTD.
2. NUMBER AND STREET ADDRESS: 1624 70TH AVENUE, MAPLERIDGE INDUSTRIAL PARK
3. CITY - TOWN - VILLAGE: EDMONTON
4. STATE: ALBERTA CANADA
5. ZIP: T6P 1P5
6. OWNER CLASSIFICATION: A [X] COMMERCIAL; B [ ] INDUSTRIAL; C [ ] UTILITY; D [ ] FEDERAL; E [ ] STATE; F [ ] MUNICIPAL; G [ ] EDUC INST; H [ ] HOSPITAL; I [ ] RESIDENTIAL; J [ ] OTHER
7. NAME & TITLE OF OWNERS REPRESENTATIVE: TONY ROJEK, VICE PRESIDENT, ENGINEERING
8. TELEPHONE: (403) 440-6054
9. NAME OF AUTHORIZED AGENT: NGE ENTERPRISES, INC.
10. TELEPHONE: (607) 762-4040
11. NUMBER AND STREET ADDRESS: 4500 VESTAL PARKWAY EAST, P.O. BOX 5231-C
12. CITY - TOWN - VILLAGE: BINGHAMTON
13. STATE: NY
14. ZIP: 13902-5231
15. NAME OF P.E. OR ARCHITECT PREPARING PLANS: PAUL BURGESS
16. N.Y.S. P.E. OR ARCHITECT LICENSE NO: 067038
17. TELEPHONE: (203) 537-0751
18. SIGNATURE OF OWNERS REPRESENTATIVE OR AGENT WHEN APPLYING FOR A PERMIT TO CONSTRUCT:
19. FACILITY NAME (IF DIFFERENT FROM OWNER / FIRM): SIMPLIFIED CLEAN SOIL PROCESS(CSP)
20. FACILITY LOCATION (NUMBER AND STREET ADDRESS): MGP SITE
21. CITY - TOWN - VILLAGE: NORWICH, NY
22. ZIP:
23. BUILDING NAME OR NUMBER:
24. FLOOR NAME OR NUMBER:
25. START UP DATE MO / YR: 4 / 95
26. DRAWING NUMBERS OF PLANS SUBMITTED:
27. PERMIT TO CONSTRUCT: A [X] NEW SOURCE TEMP.; B [ ] MODIFICATION
28. CERTIFICATE TO OPERATE: A [ ] NEW SOURCE; B [ ] MODIFICATION; C [ ] EXISTING

SEC. B

29. EMISSION POINT ID	30. GROUND ELEVATION (FT.)	31. HEIGHT ABOVE STRUCTURES (FT.)	32. STACK HEIGHT (FT.)	33. INSIDE DIMENSIONS(S) (IN.)	34. EXIT TEMPERATURE (°F)	35. EXIT VELOCITY (FT./SEC.)	36. EXIT FLOW (ACFM)	37. HEAT INPUT (MILLION BTU/HR)
001	1100	8		16	325	28.8	2415	8.37

38. CONTINUOUS MONITOR(S): A [ ] OPACITY; B [ ] SULFUR DIOXIDE; C [ ] NITROGEN OXIDES; D [ ] OXYGEN; E [ ] CARBON DIOXIDE; F [ ] OTHER

SECTION C

39. UNIT TYPE	40. UNIT MANUFACTURER'S NAME AND MODEL NUMBER	41. UNIT HEAT INPUT	42. AIR INTAKE	43. SOURCE CODE
01	CLEAVER BROOKS CB 700-200	7.9 MBTU/HR	1	

44. BURNER TYPE	45. NO. OF BURNERS	46. BURNER MANUFACTURER'S NAME AND MODEL NUMBER	47. FUEL TYPE	48. AVG. QUANTITY OF FUEL / HR	49. MAX. QUANTITY OF FUEL / HR	50. QUANTITY OF FUEL / YR
			52	3885 FT^3/HR	7770 FT^3/HR	7.77×10^5 FT^3/YR

51. HRS./DAY	52. DAYS/YEAR	53. % OPERATION BY SEASON: Winter	Spring	Summer	Fall	54. NAME OF SUPPLIER(S)
10	20		9 9	0 1		NEW YORK STATE ELECTRIC & GAS CORPORATION

55. BURNER TYPE	56. NO. OF BURNERS	57. BURNER MANUFACTURER'S NAME AND MODEL NUMBER	58. FUEL TYPE	59. AVG. QUANTITY OF FUEL / HR	60. MAX. QUANTITY OF FUEL/HR	61. QUANTITY OF FUEL/YR

62. HRS./DAY	63. DAYS/YEAR	64. % OPERATION BY SEASON: Winter	Spring	Summer	Fall	65. NAME OF SUPPLIER(S)

SEC. D

EMISSION CONTROL EQUIP I.D.	CONTROL TYPE	MANUFACTURER'S NAME AND MODEL NUMBER	DISPOSAL METHOD	DATE INSTALLED MO./YR.	USEFUL LIFE
66. N/A	67. 99	68. N/A	69. N/A	70. N/A	71. N/A
72.	73.	74.	75.	76.	77.

SECTION E

CALCULATIONS

SEE ATTACHMENT C

SECTION F

TO BE COMPLETED FOR ALL SOURCES USING ITEM 27 AND OTHER SOURCES AS DEFINED IN THE INSTRUCTION FORM 76-11-4

CONTAMINANT NAME	CAS NUMBER	EMISSIONS ACTUAL	UNIT	HOW DET.	PERMISS.	% CONTROL EFFICIENCY	HOURLY EMISSIONS (LBS/HR) ACTUAL	ANNUAL EMISSIONS (LBS/YR) ACTUAL	10^x	PERMISS
78. TOTAL PARTICULATES	79. NY075 - 00 - 0	80. 0.01	81. 11	82. 3	83.	84. 0	85. 0.08	86. 1.6	87. 1	88.
89. SULFUR DIOXIDE	90. 7446 - 09 - 5	91. 0.001	92. 11	93. 3	94.	95. 0	96. 0.01	97. 2.0	98. 0	99.
100. NITROGEN OXIDES	101. NY210 - 00 -0	102. 0.12	103. 11	104. 3	105.	106. 0	107. 1.00	108. 2.0	109. 2	110.
111. CARBON MONOXIDE	112.	113. 0.15	114. 11	115. 3	116.	117. 0	118. 1.26	119. 2.52	120. 2	121.
122.	123.	124. 0.016	125. 11	126. 3	127.	128. 0	129. 0.13	130. 2.6	131. 1	132.

Upon completion of construction sign the statement listed below and forward to the appropriate field representative

THE STATIONARY COMBUSTION INSTALLATION HAS BEEN CONSTRUCTED AND WILL BE OPERATED IN ACCORDANCE WITH STATED SPECIFICATIONS AND IN CONFORMANCE WITH ALL PROVISIONS OF EXISTING REGULATIONS

133. SIGNATURE OF AUTHORIZED REPRESENTATIVE OR AGENT | DATE

AGENCY USE ONLY

134. LOCATION CODE	135. FACILITY ID. NO.	136. U.T.M. (E)	137. U.T.M. (N)	138. SIC NUMBER	139. DATE APPL. RECEIVED	140. DATE APPL. REVIEWED	141. REVIEWED BY:
					/ /	/ /	

PERMIT TO CONSTRUCT

142. DATE ISSUED	143. EXPIRATION DATE	144. SIGNATURE OF APPROVAL	145. FEE
/ /	/ /		

146.
1. DEVIATION FROM APPROVED APPLICATION SHALL VOID THIS PERMIT
2. THIS IS NOT A CERTIFICATE TO OPERATE
3. TESTS AND/OR ADDITIONAL EMISSION CONTROL EQUIPMENT MAY BE REQUIRED PRIOR TO THE ISSUANCE OF A CERTIFICATE TO OPERATE

RECOMMENDED ACTION RE: C.O.

147. DATE ISSUED	148. EXPIRATION DATE	149. SIGNATURE OF APPROVAL	150. FEE
/ /	/ /		

151.
1. [ ] INSPECTED BY ______ DATE ______
2. [ ] INSPECTION DISCLOSED DIFFERENCES AS BUILT VS. PERMIT. CHANGES INDICATED ON FORM
3. [ ] ISSUE CERTIFICATE TO OPERATE FOR SOURCE
4. [ ] APPLICATION FOR C.O. DENIED ______ DATE ______ INITIALED

152. SPECIAL CONDITIONS:

1	2
3	4
5	6
7	8

ATTACHMENT C

Exhaust Analysis Results

Input Data Summary

Boiler Size, hp:	200
Rated Input, Btu/hr:	8,388,750
Fuel Type:	Natural Gas
Boiler Type:	Steam
Steam Pressure, psig:	10
Stack Diameter, in:	16

Exhaust Data Summary

	Input (percent)			
	25%	50%	75%	100%
Input				
Horsepower	50	100	150	200
MM Btu/hr	2.09	4.18	6.28	8.37
Temperature				
Degrees, F	260	290	310	325
Exhaust Flow				
ACFM	656	1,154	1,777	2,415
SCFM	483	816	1,224	1,831
lb/hr	2,172	3,669	5,503	7,338
Exhaust Velocity				
ft/sec	7.8	13.8	21.2	28.8
ft/min	469.5	826.3	1,272.5	1,729.7

ATTACHMENT C

BOILER HP	200
RATINGS - SEA LEVEL TO 5000 FT	
Rated Cap. Btu Output (1000 B tu/h)	6895
APPROXIMATE FUEL CONSUMPTION AT RATED CAPACITY	
Light Oil	-
Heavy Oil	-
Gas MBtu - Natural Gas	8970
POWER REQUIREMENTS - SEA LEVEL TO 3000 FT, 60 HZ	
Blower Motor Hp (except gas)	-
Gas Models (only)	10
Oil Pump Motor, Hp No. 2 Oil	1/2
Oil Pump Motor, Hp. No. 6 Oil	1/2
Oil Heaters NW No. 6 Oil	5
Air Compressor Motor Hp (Oil Mixing Only)	Air Compressor Belt-Driven From Blower Motor

ATTACHMENT C

Estimated Emission Levels

Boiler Model: CB700-200-15

Fuel: Natural Gas

	Emission Levels		
Pollutant	lb/MMBTU	lb/hr	tons/year
C O	0.15	1.26	5.50
NOx	0.12	1.00	4.40
SOx	0.001	0.01	0.04
HC	0.016	0.13	0.59
PM	0.01	0.08	0.37

Notes:
1. The emission factors in lb/MMBTU are based on the evaluation of laboratory and field test data.
2. The hourly emission rates are based on the maximum rated capacity of the boiler (8,369 MMBTU/hr).
3. The annual emission levels in tons/year are based on the boiler firing 24 hours per day 365 per year.