June 15, 2018

Mr. Ed Jones
Washington State Department of Ecology, NWRO
3190 160th Avenue SE
Bellevue, Washington 98008-5452

Re: West of 4th Site Agreed Order #DE10402 and Amendment #DE15344
Draft Work Plan for Monitoring Methane in Soil Gas (Addendum to the CVOC Pilot Study Field Implementation Work Plan), Site Unit 1

Dear Mr. Jones:

Please find enclosed the Draft Work Plan for Monitoring Methane in Soil Gas, Site Unit 1. This report was prepared by Aspect Consulting on behalf of the four potentially liable persons (PLPs) [Art Brass Plating, Blaser Die Casting, Capital Industries, and PSC Environmental Services, LLC] identified by Ecology in the Agreed Order #DE10402 for the West of 4th Site.

Sincerely,

Dana Cannon

Dana Cannon, LHG
W4 Project Coordinator
dcannon@aspectconsulting.com

Attachments: Draft Work Plan for Monitoring Methane in Soil Gas (Addendum to the CVOC Pilot Study Field Implementation Work Plan), Site Unit 1

WORK PLAN FOR MONITORING METHANE IN SOIL GAS (ADDENDUM TO THE CVOC PILOT STUDY FIELD IMPLEMENTATION WORK PLAN)

W4 Group - Site Unit 1

Prepared for: West of 4th Group

Project No. 050067 • June 15, 2018 Ecology Review Draft

earth + water

Aspect CONSULTING

WORK PLAN FOR MONITORING METHANE IN SOIL GAS (ADDENDUM TO THE CVOC PILOT STUDY FIELD IMPLEMENTATION WORK PLAN)

W4 Group - Site Unit 1

Prepared for: West of 4th Group

Project No. 050067 • June 15, 2018 Ecology Review Draft

Aspect Consulting, LLC

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V:\050067 Art Brass Plating\Pilot Study\CVOCs\Methane Monitoring Work Plan\Ecology Review Draft\Methane Mon WP_CVOC Pilot Study_Ecol Rev Draft_20160615.docx

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1 Introduction

This "Work Plan for Monitoring Methane in Soil Gas" (Work Plan Addendum) is an addendum to the draft "CVOC[1] Pilot Study Field Implementation Work Plan" (Work Plan; Aspect Consulting, LLC [Aspect], 2018). It has been prepared by Aspect on behalf of potentially liable parties (PLPs; Art Brass Plating [ABP], Blaser Die Casting [BDC], Capital Industries [CI], and Burlington Environmental [2]) identified by the Washington State Department of Ecology (Ecology) in Agreed Order (AO) No. DE10402 for the West of 4th (W4) Site (the Site). The AO requires the four PLPs (the W4 Group) to complete a feasibility study (FS), and prepare a draft Cleanup Action Plan (CAP) for the W4 Site. The W4 Site has been divided into two site units, Site Unit 1 (SU1; ABP and Stericycle) and Site Unit 2 (SU2; BDC, CI, and Stericycle), as described in the AO. Figure 1 shows the ABP Facility locations of the four PLPs and the SU1 and SU2 boundaries.

1.1 Purpose

The purpose of the CVOC pilot study is to assess the effectiveness and cost of using *In Situ* Chemical Reduction (ISCR) and Enhanced Anaerobic Biodegradation (EAnB) to treat CVOCs in groundwater west of East Marginal Way. The pilot test layout is shown on Figure 2. The groundwater monitoring wells that will be used in the pilot test have been installed, including dose response wells DR-01 and DR-02 and performance monitoring wells MW-24, MW-24-30, MW-24-50, and PSW-01 through PSW-05. Baseline groundwater monitoring was conducted in late January 2018. Well screen intervals and selected monitoring results are summarized in Table 1. Elevated concentrations of dissolved methane were detected, ranging from 1,480 micrograms per liter (µg/L) in DR-02 to 11,500 µg/L in MW-24. Ecology has expressed concern that these elevated concentrations in groundwater may be indicative of elevated methane concentrations in soil gas, and that the planned pilot test may result in increased methane generation. The principal risk associated with methane gas is its flammability. High concentrations of methane in soil gas could migrate into confined spaces, such as utility vaults or building basements, potentially resulting in an explosion hazard. The lower explosive limit [LEL] for methane in air is 5 percent by volume which is established as criteria at the property boundary for municipal solid waste landfills in Washington Administrative Code (WAC) 173 351-200(4)(a)(ii).

To address this concern, Ecology has requested that soil gas monitoring points be installed in the pilot test area and be monitored for methane. This Work Plan Addendum

[1] CVOC is the acronym for chlorinated volatile organic compound.
[2] Burlington Environmental, LLC, is a wholly owned subsidiary of PSC Environmental Services, LLC, which is a wholly owned subsidiary of Stericycle Environmental Solutions, Inc., hereafter referred to in this document as "Stericycle" for simplicity.

addresses monitoring point installation and baseline soil gas monitoring, which are hereby incorporated into the final pilot study design.

1.2 Report Organization

Subsequent sections of this report are organized as follows:

- **Section 2** addresses installation of soil gas monitoring points.
- **Section 3** addresses soil gas monitoring, including instrument calibration, monitoring procedures, monitoring schedule and reporting, and a contingency plan.
- **Section 4** provides references used in the preparation of this report.

The text references tables and figures that support the text and illustrate the proposed pilot testing activities.

Appendices to this report provide supporting information referenced in the text. These include a materials safety data sheet (MSDS) for methane and procedures for calibration and use of the soil gas monitoring instrument.

2 Installation of Soil Gas Monitoring Points

2.1 Proposed Monitoring Point Locations

Three soil gas monitoring points (SG-01 through SG-03) are proposed, to be installed at the approximate locations shown on Figure 2. The monitoring locations are intended to be as near as practicable to the buildings on either side of South Fidalgo Street, while still being readily accessible for monitoring (i.e., far enough from the buildings that they are unlikely to be covered by parked cars). Two of the points (SG-01 and SG-02) are located immediately downgradient of the reagent injection lines (purple circles on Figure 2). If reagent injection results in increased soil gas methane concentrations, the increase is expected to be most pronounced in the vicinity of these wells. SG-03 is located approximately 130 feet downgradient of SG-02. It is located on the south side of South Fidalgo Street (a parking lot borders the north side of the street) near MW-24, where the highest dissolved methane concentration in groundwater was detected[3].

Monitoring point locations will be adjusted in the field, as needed, to avoid on-street parking areas and other potential obstructions, and to reduce interference with traffic flow along South Fidalgo Street.

2.2 Monitoring Point Construction

Soil gas monitoring point construction notes and detail are provided on Figure 3. The borings will be advanced using direct-push techniques, and the surface completions will be traffic-rated 8-inch-diameter flush monuments. Screen bottom depths are approximately 4 feet below ground surface (bgs) for SG-01 and SG-02, and 3 feet bgs for SG-03. These depths were selected to be as close as practicable to the water table while minimizing the likelihood of screen flooding during periods of unusually high water table.

A comprehensive utility survey will be performed prior to monitoring point installation, including a public utility locate through the Washington Utility Notification Center, a private utility locate by Applied Professional Services, Inc (APS), and a review of available public and private as-built drawings. A City of Seattle street-use permit will be obtained, and the business owner/operators in this busy corridor will be notified of planned activities. Investigative-derived waste (IDW) will be disposed of as outlined in the final CVOC Pilot Study Work Plan (Aspect, 2017).

2.3 Installation Schedule

The soil gas monitoring points will be installed as soon as possible following Ecology approval of this Work Plan Addendum. The Final Work Plan will be prepared and submitted to Ecology after these monitoring points have been installed and baseline monitoring completed.

[3] Note, however, that MW-24 is screened shallower than the other wells (Table 1), so it is not an "apples-to-apples" comparison.

3 Soil Gas Monitoring

A LANDTEC GEM™2000 Gas Analyzer (GEM 2000) will be used in the field to monitor soil gas for methane, carbon dioxide, and oxygen[4]. The GEM 2000 measures concentrations of all three gases down to 0.1 percent by volume[5]. This corresponds to 1/50th of the LEL for methane (5.0 percent by volume).

3.1 Instrument Calibration

Table B.1 in Appendix B provides a field calibration procedure for the GEM 2000. The instrument will be calibrated prior to each monitoring event.

3.2 Monitoring Procedure

Table B.2 in Appendix B provides the GEM 2000 monitoring procedure to be used. The instrument pumps gas at a rate of roughly 250 cubic centimeters per minute (cc/min) under a modest vacuum. Each monitoring point will be purged by running the GEM 2000 pump for approximately 2 minutes. Concentrations of methane, carbon dioxide, and oxygen will then be recorded at 2-minute intervals over a 10-minute period, to obtain six sets of readings.

Any proposed modifications to the soil gas monitoring procedure will be discussed with Ecology prior to implementation.

3.3 Monitoring Schedule and Next Steps

The pilot study implementation schedule is provided in the Work Plan. The baseline soil gas monitoring event described in this Work Plan Addendum will be conducted prior to finalizing the Work Plan. If methane is detected above the LEL in soil gas, the next steps will be discussed with Ecology (i.e., notifications and/or additional investigation) Additionally, any continued monitoring of the soil gas monitoring points, and any associated contingency plans (including actionable levels and mitigation steps) will be outlined in the final Work Plan.

[4] The GEM 2000 monitors simultaneously for all three compounds. While methane is the primary focus, information on carbon dioxide and oxygen concentrations in soil gas may provide useful information with regard to the source of the methane, potential short-circuiting, etc.

[5] LANDTEC claims a typical instrument accuracy of ±0.3 percent for methane concentrations below 5 percent by volume.

4 References

Aspect Consulting, LLC (Aspect), 2017, CVOC Pilot Study Work Plan. December 21, 2017.

Aspect Consulting, LLC (Aspect), 2018, CVOC Pilot Study Field Implementation Work Plan. April 4, 2018 (Agency Review Draft).

5 Limitations

Work for this project was performed for the West of 4th Group (Client), and this report was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

All reports prepared by Aspect Consulting for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect Consulting. Aspect Consulting's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

TABLE

Table 1. Well Screen Intervals and Baseline Groundwater Monitoring Results

Project No. 050067, Art Brass Plating, Seattle, WA

		Dose Response Wells		Downgradient Performance Wells							Upgradient Performance
Well ID		**DR-01**	**DR-02**	**PSW-01**	**PSW-02**	**PSW-03**	**PSW-04**	**MW-24**	**MW-24-30**	**MW-24-50**	**PSW-05**
Groundwater Monitoring Interval		**Shallow**	**Shallow**	**Shallow**	**Shallow**	**Shallow**	**Shallow**	**Water Table**	**Shallow**	**Intermediate**	**Shallow**
Well Screen Interval (feet bgs)		**20 to 30**	**20 to 30**	**20 to 30**	**20 to 30**	**20 to 30**	**21 to 31**	**5 to 15**	**20 to 30**	**40 to 50**	**20 to 30**
Monitoring Date		**01/29/2018**	**01/30/2018**	**01/30/2018**	**01/30/2018**	**01/30/2018**	**01/30/2018**	**01/31/2018**	**01/29/2018**	**01/30/2018**	**01/30/2018**
Depth to Water (feet below TOC)		**5.68**	**5.83**	**6.06**	**5.62**	**6.04**	**6.12**	**4.12**	**5.89**	**5.72**	**6.06**
Sample ID		**DR-1-012918**	**DR-2-013018**	**PSW-1-013018**	**PSW-2-013018**	**PSW-3-013018**	**PSW-4-013018**	**MW-24-013118**	**MW-24-30-012918**	**MW-24-50-013018**	**PSW-5-013018**
CVOCs	**Units**										
1,1-Dichloroethane	ug/L	**1.17**	**2.03**	**1.22**	**1.64**	**2.19**	**0.92**	< 0.20 U	**2**	< 0.20 U	**0.76**
1,1-Dichloroethene	ug/L	< 1 U	**0.53**	**1.42**	**0.55**	**0.59**	**0.55**	< 0.20 U	**3.24**	< 0.20 U	**0.29**
Trichloroethene (TCE)	ug/L	**53.7 J**	**382**	**20**	**45.1**	**328**	**124**	< 0.20 U	< 1 UJ	< 0.20 U	**264**
cis-1,2-Dichloroethene (DCE)	ug/L	**201**	**124**	**107**	**277**	**130**	**158**	**0.13 J**	**256**	< 0.20 U	**63.3**
trans-1,2-Dichloroethene	ug/L	**4.72**	**7.49**	**4.36**	**5.82**	**5.92**	**6.15**	< 0.20 U	**9.85**	< 0.20 U	**5.05**
Vinyl Chloride	ug/L	**13.5**	**9.47**	**16**	**16.5**	**12**	**27.4**	< 0.20 U	**65.1**	< 0.20 U	**6.61**
Dissolved Gases											
Ethane	ug/L	< 1.23 U	**10.2**	**10.9**	**8.7**	**7.12**	**6.93**	< 1.23 U	**13.6**	< 1.23 U	< 1.23 U
Ethene	ug/L	< 1.14 U	< 1.14 U	< 1.14 U	< 1.14 U	< 1.14 U	< 1.14 U	< 1.14 U	**8.82**	< 1.14 U	< 1.14 U
Methane	ug/L	**7,210**	**1,480**	**11,200**	**5,110**	**1,640**	**5,660**	**11,500**	**5,700**	**6,290**	**1,680**
General Chemistry Parameters											
Chloride	mg/L	**18.7**	**14.6**	**18.8**	**16.8**	**14.8**	**17**		**16.5**	**11.1**	**14.7**
Sulfate	mg/L	**40.5**	**35.7**	**11.1**	**11.4**	**26.3**	**31.5**		**5.4**	**0.198**	**16.3**
Total Organic Carbon	mg/L	**18.2**	**5.96**	**6.51**	**6.29**	**5.3**	**8.31**		**6.64**	**4.1**	**6.76**
Field Parameters											
Temperature	deg C	**14.1**	**13.2**	**14.7**	**14**	**13.9**	**14.6**	**11.6**	**13.9**	**14.6**	**13.5**
Specific Conductance	uS/cm	**530**	**397.1**	**404**	**308.8**	**374.2**	**424**	**642**	**343**	**101.9**	**419.1**
Dissolved Oxygen	mg/L	**0.09**	**0.13**	**0.09**	**0.13**	**0.16**	**0.1**	**0.1**	**0.13**	**0.1**	**0.13**
pH	pH units	**6.62**	**6.67**	**6.62**	**6.76**	**6.51**	**6.76**	**6.75**	**6.61**	**6.21**	**6.5**
Oxidation Reduction Potential	mV	**-53.9**	**-0.3**	**-46.5**	**-3.8**	**-40.9**	**-65.3**	**-51**	**-69.9**	**-3.8**	**-35**
Turbidity	NTU	**20.1**	**20.2**	**11**	**98**	**13**	**26**	**13**	**9.9**	**1**	**12**
Iron, Ferrous, Fe+2	ppm	**2.5**	**6**	**3**	**1.5**	**2**	**2**	**1.75**	**6**	**1.5**	**2**

µg/L - micrograms per liter
µS/cm - microsiemens per centimeter
bgs - below ground surface
deg C - degrees Celsius
J - reported result is an estimate
mg/L - milligrams per liter
mV -millivolts
NTU - nephelometric turbidity units
TOC - top of casing
U - not detected at or above the reported result

Notes:

1) Only selected results are shown in this table. Refer to the Work Plan (Aspect, 2018) for additional baseline groundwater moniitoring results.

FIGURES

Exploration Locations

Symbol (Exploration Type)

- Monitoring Well
- Soil Boring/Probe
- Porewater

Color (Exploration Sampler)

- Art Brass Plating
- Blaser Die Casting
- Capital Industries
- Philip Services Corporation
- Other Companies

- Art Brass Plating Study Area
- Building Outlines (as presented on other figures)

An orange halo indicates multiple parties sampled from one location

OHIO AVE S
UTAH AVE S
1ST AVE S
2ND AVE S
3RD AVE S
4TH AVE S
5TH AVE S
E MARGINAL WAY S (HIGHWAY 99)
S LUCILE ST
S FINDLAY ST
S ORCAS ST
S MEAD ST
S FIDALGO ST

PILOT TESTING LOCATION

N

0 200 400
Feet

Site Map Showing CVOC Pilot Study Location

Methane Monitoring Work Plan
Art Brass Plating
Seattle, Washington

DRAFT

Aspect Consulting	JUN-2018	BY: EAC	FIGURE NO. 1
	PROJECT NO. 050067	REVISED BY: DAH/SCC	

APPROXIMATE GROUNDWATER FLOW DIRECTION

6" diameter sewer pipe

PSW-05

PSW-01

SG-01

DR-01

PSC-Q32-D

PSW-02

STG-GP-6

S F I D A L G O S T

DR-02

PSC-Q32-G

STG-GP-5

PSC-Q32-B

PSW-03

SG-02

6" diameter sewer pipe

MW-24-30

MW-24-50

PSC-Q32

PSW-04

MW-24

SG-03

2" diameter sewer pipe

Pilot Test Monitoring Locations

- Proposed Soil Gas Monitoring Point
- Dose-response Monitoring Well
- Downgradient Performance Monitoring Well
- Upgradient Monitoring Well
- Direct Push Injection Point
- Target Radius of Influence
- Temporary Soil Boring/Probe
- Control Monitoring Well
- Building
- Road Edge

N

0 15 30

Feet

Note: All locations are approximate.

DRAFT

Pilot Test Layout and Proposed Soil Gas Monitoring Locations

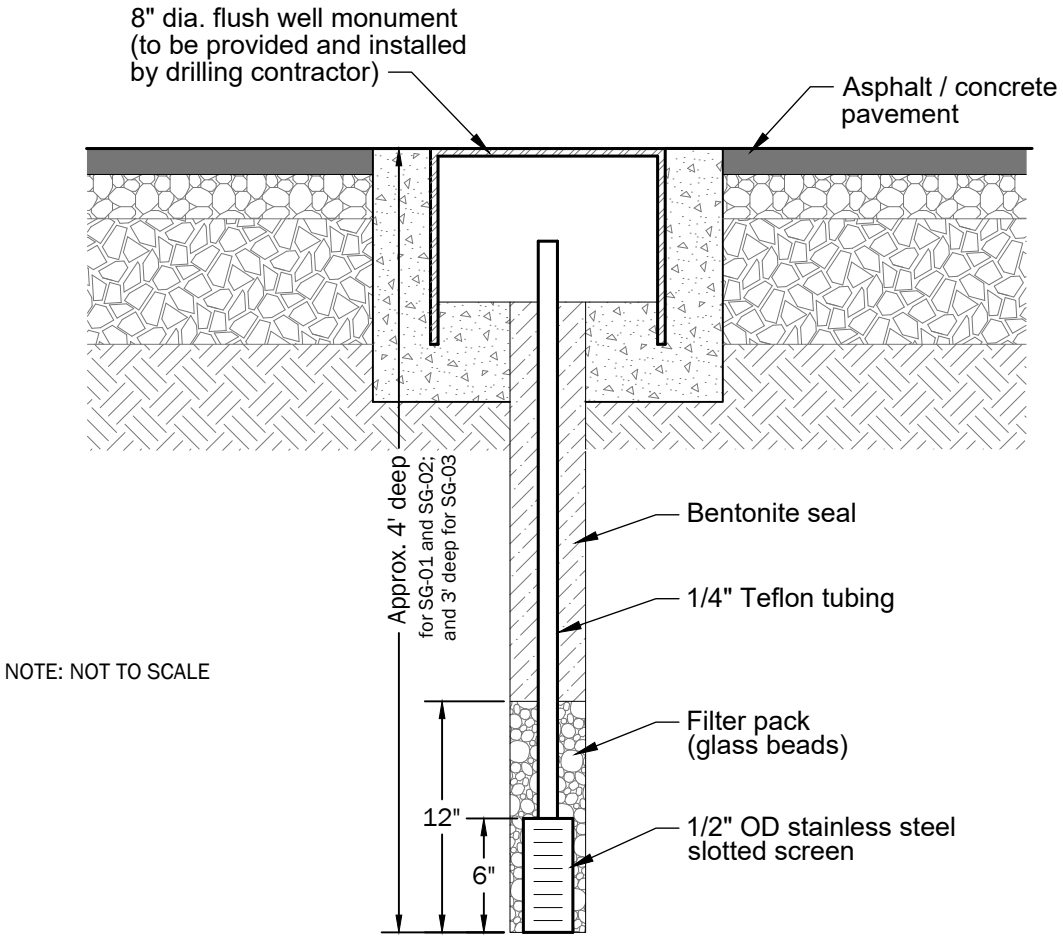
Methane Monitoring Work Plan
Art Brass Plating
Seattle, Washington

Aspect Consulting	JUN-2018	BY: EAC	FIGURE NO. 2
	PROJECT NO. 050067	REVISED BY: DAH/SCC	

GIS Path: T:\projects_8\Artbrass\PilotTest\mxd_2017\Delivered\Methane Monitoring Work Plan\02 Pilot Test Layout and Proposed Soil Gas Monitoring Locations.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 6/7/2018 || User: trullen || Print Date: 6/14/2018

Construction Detail

2" OD Direct Push Boring



NOTE: NOT TO SCALE

General Notes

1. Copies of all permits shall be maintained on job site at all times. The Contractor shall comply with all permit requirements.
2. Contractor shall locate all site utilities prior to beginning the work.
3. Contractor shall protect existing site structures, utilities, and pavement from damage during the work.
4. Contractor shall assume responsibility for job site safety for the duration of the work.
5. Work shall be warranted for a period of one year from the date of substantial completion. Any defects that appear in that time shall be remedied by and at the expense of the Contractor.

Drilling and Installation Notes

1. Drilling and soil gas monitoring point installation shall be performed according to all applicable regulations.
2. Soil gas monitoring points shall be drilled with direct-push techniques.
3. Soil gas monitoring points shall be completed by the driller with flush-mount monuments.
4. Variances for modified well installation will be obtained by Aspect Consulting, if necessary.
5. Soil sampling and drilling shall be conducted with decontaminated equipment.

DRAFT

Soil Gas Monitoring Point Construction Notes and Detail

Methane Monitoring Work Plan
Art Brass Plating
Seattle, Washington

Aspect CONSULTING	Jun-2018	BY: DAH/SCC	FIGURE NO. 3
	PROJECT NO. 050067	REVISED BY: -	

APPENDIX A

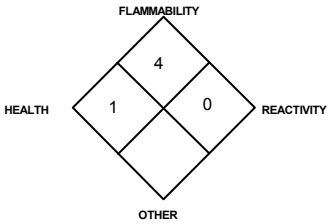
Material Safety Data Sheet (MSDS) for Methane

MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI and Canadian WHMIS Standards

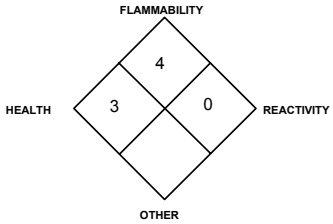
METHANE GAS

NFPA RATING



LIQUID METHANE

NFPA RATING



PART I *What is the material and what do I need to know in an emergency?*

1. PRODUCT IDENTIFICATION

CHEMICAL NAME; CLASS: **METHANE - CH_4, Gaseous**
METHANE - CH_4, Liquefied (Cryogenic)
Document Number: 001033

PRODUCT USE: Fuel and for general analytic/synthetic chemical uses.

SUPPLIER/MANUFACTURER'S NAME: AIRGAS INC.
ADDRESS: 259 N. Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283

BUSINESS PHONE: 1-610-687-5253
EMERGENCY PHONE: 1-800-949-7937
International: 423-479-0293

DATE OF PREPARATION: May 12, 1996
REVISION DATE: January 3, 2001

2. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	mole %	EXPOSURE LIMITS IN AIR					
			ACGIH		OSHA			
			TLV ppm	STEL ppm	PEL ppm	STEL ppm	IDLH ppm	OTHER
Methane	74-82-8	> 99%	There are no specific exposure limits for Methane. Methane is a simple asphyxiant (SA). Oxygen levels should be maintained above 19.5%.					
Maximum Impurities		< 1%	None of the trace impurities in this product contribute significantly to the hazards associated with the product. All hazard information pertinent to this product has been provided in this Material Safety Data Sheet, per the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200) and State equivalent standards.					

NE = Not Established C = Ceiling Limit See Section 16 for Definitions of Terms Used

NOTE: All WHMIS required information is included. It is located in appropriate sections based on the ANSI Z400.1-1993 format.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: Methane is an odorless, colorless gas, or a colorless, odorless liquid in its cryogenic form. Both the liquid and the gas pose a serious fire hazard when accidentally released. The liquid will rapidly boil to the gas at standard temperatures and pressures. As a gas, it will act as a simple asphyxiant and present a significant health hazard by displacing the oxygen in the atmosphere. The gas is lighter than air and may spread long distances. Distant ignition and flashback are possible. The liquefied gas can cause frostbite to any contaminated tissue. Flame or high temperature impinging on a localized area of the cylinder of Methane can cause the cylinder to rupture without activating the cylinder's relief devices. Provide adequate fire protection during emergency response situations. Allow the released gas to dissipate in the atmosphere.

SYMPTOMS OF OVEREXPOSURE BY ROUTE OF EXPOSURE: The most significant route of overexposure for this gas is by inhalation. The following paragraphs describe symptoms of exposure by route of exposure.

INHALATION: High concentrations of this gas can cause an oxygen-deficient environment. Individuals breathing such an atmosphere may experience symptoms which include headaches, ringing in ears, dizziness, drowsiness, unconsciousness, nausea, vomiting, and depression of all the senses. Under some circumstances of overexposure, death may occur. The effects associated with various levels of oxygen are as follows:

CONCENTRATION	**SYMPTOMS OF EXPOSURE**
12-16% Oxygen:	Breathing and pulse rate increased, muscular coordination slightly disturbed.
10-14% Oxygen:	Emotional upset, abnormal fatigue, disturbed respiration.
6-10% Oxygen:	Nausea and vomiting, collapse or loss of consciousness.
Below 6%:	Convulsive movements, possible respiratory collapse, and death.

OTHER POTENTIAL HEALTH EFFECTS: Contact with cryogenic liquid or rapidly expanding gases (which are released under high pressure) may cause frostbite. Symptoms of frostbite include change in skin color to white or grayish-yellow. The pain after contact with the liquid can quickly subside.

HAZARDOUS MATERIAL INFORMATION SYSTEM

HEALTH	(BLUE)	1
FLAMMABILITY	(RED)	4
REACTIVITY	(YELLOW)	0
PROTECTIVE EQUIPMENT		B

EYES	RESPIRATORY	HANDS	BODY
	See Section 8		See Section 8

For routine industrial applications

See Section 16 for Definition of Ratings

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in **Lay Terms**. Overexposure to Methane may cause the following health effects:

ACUTE: The most significant hazard associated with this gas is inhalation of oxygen-deficient atmospheres. Symptoms of oxygen deficiency include respiratory difficulty, headache, dizziness, and nausea. At high concentrations, unconsciousness or death may occur. Contact with cryogenic liquid or rapidly expanding gases may cause frostbite.

CHRONIC: There are currently no known adverse health effects associated with chronic exposure to Methane.

TARGET ORGANS: Respiratory system.

PART II *What should I do if a hazardous situation occurs?*

4. FIRST-AID MEASURES

RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO METHANE WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus and Fire-Retardant Personal Protective equipment should be worn. Adequate fire protection must be provided during rescue situations.

4. FIRST-AID MEASURES (Continued)

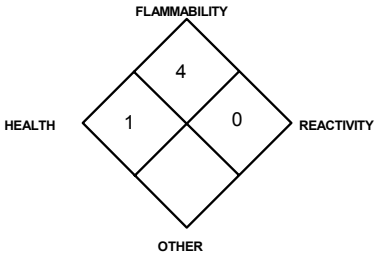
Remove victim(s) to fresh air as quickly as possible. Trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary. Only trained personnel should administer supplemental oxygen.

In case of frostbite, place the frostbitten part in warm water. DO NOT USE HOT WATER. If warm water is not available, or is impractical to use, wrap the affected parts gently in blankets. Alternatively, if the fingers or hands are frostbitten, place the affected area in the armpit, Encourage victim to gently exercise the affected part while being warmed. Seek immediate medical attention. Victim(s) must be taken for medical attention. Rescuers should be taken for medical attention, if necessary. Take copy of label and MSDS to physician or other health professional with victim(s).

5. FIRE-FIGHTING MEASURES

METHANE GAS

NFPA RATING



FLASH POINT (Closed Cup):
-187°C (-306°F)

AUTOIGNITION TEMPERATURE:
537°C (999°F)

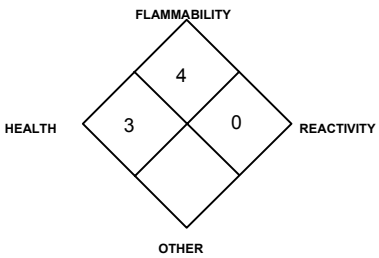
FLAMMABLE LIMITS (in air by volume, %):

Lower (LEL): 5.0%
Upper (UEL): 15.0%

See Section 16 for Definition of Ratings

LIQUID METHANE

NFPA RATING



FIRE EXTINGUISHING MATERIALS: Extinguish fires of this gas by shutting off the source of the gas. Use water spray to cool fire-exposed containers, structures, and equipment.

UNUSUAL FIRE AND EXPLOSION HAZARDS: When involved in a fire, this gas will ignite and produce toxic gases including carbon monoxide and carbon dioxide. An extreme explosion hazard exists in areas in which the gas has been released, but the material has not yet ignited.

DANGER! Fires impinging (direct flame) on the outside surface of unprotected pressure storage vessels of Methane can be very dangerous and lead to container failure. The resulting fire and explosion can result in severe equipment damage and personnel injury or death over a large area around the vessel. For massive fires in large areas, use unmanned hose holder or monitor nozzles; if this is not possible, withdraw from area and allow fire to burn.

RESPONSE TO FIRE INVOLVING CRYOGEN: Cryogenic liquids can be particularly dangerous during fires because of their potential to rapidly freeze water. Careless use of water may cause heavy icing. Furthermore, relatively warm water greatly increases the evaporation rate of Methane. If large concentrations of Methane gas are present, the water vapor in the surrounding air will condense, creating a dense fog that may make it difficult to find fire exits or equipment. Liquid Methane, when exposed to the atmosphere, will produce a cloud of ice/fog in the air upon its release. A flammable mixture will exist within the vapor cloud and it is advisable that personnel keep well outside the area of visible moisture.

Explosion Sensitivity to Mechanical Impact: Not sensitive.
Explosion Sensitivity to Static Discharge: Static discharge may cause Methane to ignite explosively.

SPECIAL FIRE-FIGHTING PROCEDURES: Structural fire-fighters must wear Self-Contained Breathing Apparatus and full protective equipment. The best fire-fighting technique may be simply to let the burning gas escape from the pressurized cylinder, tank car, or pipeline. Stop the leak before extinguishing fire. If the fire is extinguished before the leak is sealed, the still-leaking gas could explosively re-ignite without warning and cause extensive damage, injury, or fatality. In this case, increase ventilation (in enclosed areas) to prevent flammable or explosive mixture formation. For large releases, consider evacuation. Refer to the North American Emergency Response Guidebook for additional information.

6. ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a release, clear the affected area, protect people, and respond with trained personnel. Adequate fire protection must be provided. Minimum Personal Protective Equipment should be **Level B: fire-retardant protective clothing, gloves resistant to tears, and Self-Contained Breathing Apparatus.**

Use only non-sparking tools and equipment. Locate and seal the source of the leaking gas. Protect personnel attempting the shut-off with water-spray. Allow the gas, which is lighter than air, to dissipate. Liquid Methane, when exposed to the atmosphere, will produce a cloud of ice/fog in the air upon its release. A flammable mixture will exist within the vapor cloud, and it is advisable that personnel keep well outside the area of visible moisture. If cryogenic liquid is released, keep area clear and allow the liquid to evaporate. The gas that is then formed should be allowed to dissipate.

Monitor the surrounding area for combustible gas levels and oxygen. The atmosphere must have at least 19.5 percent oxygen before personnel can be allowed in the area without Self-Contained Breathing Apparatus. Combustible gas concentration must be below 10% of the LEL (LEL = 5.0%) prior to entry. Attempt to close the main source valve prior to entering the area. If this does not stop the release (or if it is not possible to reach the valve), allow the gas to release in-place or remove it to a safe area and allow the gas to be released there.

RESPONSE TO CRYOGENIC RELEASE: Clear the affected area and allow the liquid to evaporate and the gas to dissipate. After the gas is formed, follow the instructions provided in the previous paragraphs. If the area must be entered by emergency personnel, SCBA, Kevlar gloves, and appropriate foot and leg protection must be worn.

THIS IS AN EXTREMELY FLAMMABLE GAS. Protection of all personnel and the area must be maintained.

PART III *How can I prevent hazardous situations from occurring?*

7. HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting Methane IN YOU. Do not eat or drink while handling chemicals. Be aware of any signs of dizziness or fatigue; exposures to fatal concentrations of Methane could occur without any significant warning symptoms.

STORAGE AND HANDLING PRACTICES: Cylinders should be stored in dry, well-ventilated areas away from sources of heat. Compressed gases can present significant safety hazards. Store containers away from heavily trafficked areas and emergency exits. Post “No Smoking or Open Flames” signs in storage or use areas.

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: Protect cylinders against physical damage. Store in cool, dry, well-ventilated area, away from sources of heat, ignition and direct sunlight. Do not allow area where cylinders are stored to exceed 52°C (125°F). Isolate from oxidizers such as oxygen, chlorine, or fluorine. Use a check valve or trap in the discharge line to prevent hazardous backflow. Post “No Smoking or Open Flame” signs in storage and use areas. Cylinders should be stored upright and be firmly secured to prevent falling or being knocked over. Cylinders can be stored in the open, but in such cases, should be protected against extremes of weather and from the dampness of the ground to prevent rusting. Never tamper with pressure relief devices in valves and cylinders. Electrical equipment should be non-sparking or explosion proof. The following rules are applicable to work situations in which cylinders are being used:

Before Use: Move cylinders with a suitable hand truck. Do not drag, slide, or roll cylinders. Do not drop cylinders or permit them to strike each other. Secure cylinders firmly. Leave the valve protection cap, if provided, in place until cylinder is ready for use.

During Use: Use designated CGA fittings and other support equipment. Do not use adapters. Do not heat cylinder by any means to increase the discharge rate of the product from the cylinder. Use check valve or trap in discharge line to prevent hazardous backflow into the cylinder. Do not use oils or grease on gas-handling fittings or equipment.

After Use: Close main cylinder valve. Replace valve protection cap, if provided. Mark empty cylinders “EMPTY”.

NOTE: Use only DOT or ASME code containers. Earth-ground and bond all lines and equipment associated with Methane. Close valve after each use and when empty. Cylinders must not be recharged except by or with the consent of owner. For additional information refer to the Compressed Gas Association Pamphlet P-1, *Safe Handling of Compressed Gases in Containers*. Additionally, refer to CGA Bulletin SB-2 “*Oxygen Deficient Atmospheres*”.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain that application equipment is locked and tagged-out safely. Purge gas handling equipment with inert gas (e.g., nitrogen) before attempting repairs.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation. Local exhaust ventilation is preferred, because it prevents Methane dispersion into the work place by eliminating it at its source. If appropriate, install automatic monitoring equipment to detect the presence of potentially explosive air-gas mixtures and the level of oxygen. Monitoring devices should be installed near the ceiling.

RESPIRATORY PROTECTION: Maintain oxygen levels above 19.5% in the workplace. Use supplied air respiratory protection if oxygen levels are below 19.5% or during emergency response to a release of Methane. If respiratory protection is required, follow the requirements of the Federal OSHA Respiratory Protection Standard (29 CFR 1910.134) or equivalent State standards.

EYE PROTECTION: Splash goggles or safety glasses, for protection from rapidly expanding gases and splashes of liquid Methane.

HAND PROTECTION: Wear gloves resistant to tears when handling cylinders of Methane. Use low-temperature protective gloves when working with containers of liquid Methane.

BODY PROTECTION: Use body protection appropriate for task. Transfer of large quantities under pressure may require protective equipment appropriate to protect employees from splashes of liquefied product, as well as fire retardant items.

9. PHYSICAL and CHEMICAL PROPERTIES

VAPOR DENSITY: 0.6784 kg/m^3 (0.042 35 lb/ft^3)
SPECIFIC GRAVITY (air = 1): 0.555
SOLUBILITY IN WATER: Very slight.
EXPANSION RATIO: 626 (cryogenic liquid)
ODOR THRESHOLD: Not applicable. Odorless.
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.
SPECIFIC VOLUME: 23.7
FREEZING POINT: -182.2°C (-296°F)
BOILING POINT @ 1 atm: -161°C (-258.7°F)
EVAPORATION RATE (n-BuAc): Not applicable.
VAPOR PRESSURE (psia): Not applicable.
pH: Not applicable.

APPEARANCE AND COLOR: Colorless, odorless gas, or colorless, odorless, cryogenic liquid.
HOW TO DETECT THIS SUBSTANCE (warning properties): There are no distinct warning properties. In terms of leak detection, fittings and joints can be painted with a soap solution to detect leaks, which will be indicated by a bubble formation.
NOTE: This gas is lighter than air and must not be allowed to accumulate in elevated locations.

10. STABILITY and REACTIVITY

STABILITY: Stable.

DECOMPOSITION PRODUCTS: When ignited in the presence of oxygen, this gas will burn to produce carbon monoxide, carbon dioxide.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Strong oxidizers (e.g., chlorine, bromine pentafluoride, oxygen, oxygen difluoride, and nitrogen trifluoride).

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Contact with incompatible materials and exposure to heat, sparks, and other sources of ignition. Cylinders exposed to high temperatures or direct flame can rupture or burst.

PART IV *Is there any other useful information about this material?*

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: There are no specific toxicology data for Methane. Methane is a simple asphyxiant, which acts to displace oxygen in the environment.

SUSPECTED CANCER AGENT: Methane is not found on the following lists: FEDERAL OSHA Z LIST, NTP, IARC, CAL/OSHA, and therefore, is neither considered to be nor suspected to be a cancer-causing agent by these agencies.

IRRITANCY OF PRODUCT: Methane is not irritating; however, contact with rapidly expanding gases can cause frostbite to exposed tissue.

SENSITIZATION TO THE PRODUCT: Methane does not cause sensitization with prolonged or repeated contact.

11. TOXICOLOGICAL INFORMATION (Continued)

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of Methane on the human reproductive system.

Mutagenicity: No mutagenicity effects have been described for Methane.
Embryotoxicity: No embryotoxic effects have been described for Methane.
Teratogenicity: No teratogenicity effects have been described for Methane.
Reproductive Toxicity: No reproductive toxicity effects have been described for Methane.

A mutagen is a chemical which causes permanent changes to genetic material (DNA) such that the changes will propagate through generational lines. An embryotoxin is a chemical which causes damage to a developing embryo (i.e., within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A teratogen is a chemical which causes damage to a developing fetus, but the damage does not propagate across generational lines. A reproductive toxin is any substance which interferes in any way with the reproductive process.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Acute or chronic respiratory conditions may be aggravated by overexposure to the components of Methane.

RECOMMENDATIONS TO PHYSICIANS: Administer oxygen if necessary. Treat symptoms and eliminate exposure.

BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, Biological Exposure Indices (BEIs) are not applicable for Methane.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: Methane occurs naturally in the atmosphere. This gas will be dissipated rapidly in well-ventilated areas.
EFFECT OF MATERIAL ON PLANTS or ANIMALS: Any adverse effect on animals would be related to oxygen-deficient environments. No adverse effect is anticipated to occur to plant-life, except for frost produced in the presence of rapidly expanding gases.
EFFECT OF CHEMICAL ON AQUATIC LIFE: No evidence is currently available on the effects of Methane on aquatic life.

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Product removed from the cylinder must be disposed of in accordance with appropriate Federal, State, and local regulations. Return cylinders with residual product to Airgas. Do not dispose locally.

14. TRANSPORTATION INFORMATION

THIS MATERIAL IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

For Methane Gas:

PROPER SHIPPING NAME:	Methane, compressed
HAZARD CLASS NUMBER and DESCRIPTION:	2.1 (Flammable Gas)
UN IDENTIFICATION NUMBER:	UN 1971
PACKING GROUP:	Not Applicable
DOT LABEL(S) REQUIRED:	Flammable Gas

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 115

For Liquefied Methane:

PROPER SHIPPING NAME:	Methane, refrigerated liquid
HAZARD CLASS NUMBER and DESCRIPTION:	2.1 (Flammable Gas)
UN IDENTIFICATION NUMBER:	UN 1972
PACKING GROUP:	Not Applicable
DOT LABEL(S) REQUIRED:	Flammable Gas

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 115

MARINE POLLUTANT: Methane is not classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B).

15. REGULATORY INFORMATION

U.S. SARA REPORTING REQUIREMENTS: Methane is not subject to the reporting requirements of Sections 302, 304, and 313 of Title III of the Superfund Amendments and Reauthorization Act.

U.S. SARA THRESHOLD PLANNING QUANTITY: Not applicable.

U.S. CERCLA REPORTABLE QUANTITY (RQ): Not applicable.

CANADIAN DSL/NDSL INVENTORY STATUS: Methane is on the DSL Inventory.

U.S. TSCA INVENTORY STATUS: Methane is listed on the TSCA Inventory.

OTHER U.S. FEDERAL REGULATIONS: Methane is subject to the reporting requirements of Section 112(r) of the Clean Air Act. The Threshold Quantity for this gas is 10,000 lb. Depending on specific operations involving the use of Isobutylene, the regulations of the Process Safety Management of Highly Hazardous Chemicals may be applicable (29 CFR 1910.119). Under this regulation Methane is not listed in Appendix A; however, any process that involves a flammable gas on-site, in one location, in quantities of 10,000 lb (4,553 kg) or greater is covered under this regulation unless it is used as a fuel.

U.S. STATE REGULATORY INFORMATION: Methane is covered under specific State regulations, as denoted below:

Alaska - Designated Toxic and Hazardous Substances: Methane.
California - Permissible Exposure Limits for Chemical Contaminants: Methane.
Florida - Substance List: No.
Illinois - Toxic Substance List: Methane.
Kansas - Section 302/313 List: No.
Massachusetts - Substance List: Methane.
Michigan - Critical Materials Register: No.
Minnesota - List of Hazardous Substances: Methane.
Missouri - Employer Information/Toxic Substance List: Methane.
New Jersey - Right to Know Hazardous Substance List: Methane.
North Dakota - List of Hazardous Chemicals, Reportable Quantities: No.
Pennsylvania - Hazardous Substance List: Methane.
Rhode Island - Hazardous Substance List: Methane.
Texas - Hazardous Substance List: No.
West Virginia - Hazardous Substance List: No.
Wisconsin - Toxic and Hazardous Substances: No.

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): Methane is not on the California Proposition 65 lists.

LABELING:

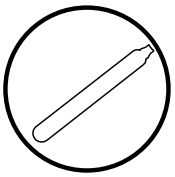
DANGER: FLAMMABLE HIGH PRESSURE GAS.
CAN FORM EXPLOSIVE MIXTURES WITH AIR.

Keep away from heat, flames, and sparks.
Store and use width adequate ventilation.
Use equipment rated for cylinder pressure.
Close valve after each use and when empty.
Use in accordance with the Material Safety Data Sheet.

DO NOT REMOVE THIS PRODUCT LABEL

CANADIAN WHMIS SYMBOLS:

Class A: Compressed Gas
Class B1: Flammable Gas



16. OTHER INFORMATION

PREPARED BY: **Airgas - SAFECOR**

The information contained herein is based on data considered accurate. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. AIRGAS, Inc. assumes no responsibility for injury to the vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, AIRGAS, Inc. assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in his use of the material.

DEFINITIONS OF TERMS

A large number of abbreviations and acronyms appear on a MSDS. Some of these which are commonly used include the following:

CAS #: This is the Chemical Abstract Service Number which uniquely identifies each constituent. It is used for computer-related searching.

EXPOSURE LIMITS IN AIR:

ACGIH - American Conference of Governmental Industrial Hygienists, a professional association which establishes exposure limits. **TLV -** Threshold Limit Value - an airborne concentration of a substance which represents conditions under which it is generally believed that nearly all workers may be repeatedly exposed without adverse effect. The duration must be considered, including the 8-hour Time Weighted Average **(TWA)**, the 15-minute Short Term Exposure Limit, and the instantaneous Ceiling Level **(C)**. Skin absorption effects must also be considered.

OSHA - U.S. Occupational Safety and Health Administration. **PEL -** Permissible Exposure Limit - This exposure value means exactly the same as a TLV, except that it is enforceable by OSHA. The OSHA Permissible Exposure Limits are based in the 1989 PELs and the June, 1993 Air Contaminants Rule (Federal Register: 58: 35338-35351 and 58: 40191). Both the current PELs and the vacated PELs are indicated. The phrase, "Vacated 1989 PEL," is placed next to the PEL which was vacated by Court Order.

IDLH - Immediately Dangerous to Life and Health **-** This level represents a concentration from which one can escape within 30-minutes without suffering escape-preventing or permanent injury. **The DFG - MAK** is the Republic of Germany's Maximum Exposure Level, similar to the U.S. PEL. **NIOSH** is the National Institute of Occupational Safety and Health, which is the research arm of the U.S. **O**ccupational **S**afety and **H**ealth **A**dministration (**OSHA**). NIOSH issues exposure guidelines called **R**ecommended **E**xposure **L**evels (**REL**s). When no exposure guidelines are established, an entry of **NE** is made for reference.

HAZARD RATINGS:

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM: Health Hazard: **0** (minimal acute or chronic exposure hazard); **1** (slight acute or chronic exposure hazard); **2** (moderate acute or significant chronic exposure hazard); **3** (severe acute exposure hazard; onetime overexposure can result in permanent injury and may be fatal); **4** (extreme acute exposure hazard; onetime overexposure can be fatal). Flammability Hazard: **0** (minimal hazard); **1** (materials that require substantial pre-heating before burning); **2** (combustible liquid or solids; liquids with a flash point of 38-93°C [100-200°F]); **3** (Class IB and IC flammable liquids with flash points below 38°C [100°F]); **4** (Class IA flammable liquids with flash points below 23°C [73°F] and boiling points below 38°C [100°F]. Reactivity Hazard: **0** (normally stable); 1 (material that can become unstable at elevated temperatures or which can react slightly with water); **2** (materials that are unstable but do not detonate or which can react violently with water); **3** (materials that can detonate when initiated or which can react explosively with water); **4** (materials that can detonate at normal temperatures or pressures).

NATIONAL FIRE PROTECTION ASSOCIATION: Health Hazard: **0** (material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials); **1** (materials that on exposure under fire conditions could cause irritation or minor residual injury); **2** (materials that on intense or continued exposure under fire conditions could cause temporary incapacitation or possible residual injury); **3** (materials that can on short exposure could cause serious temporary or residual injury); **4** (materials that under very short exposure causes death or major residual injury).

NATIONAL FIRE PROTECTION ASSOCIATION (Continued): Flammability Hazard and Reactivity Hazard: Refer to definitions for "Hazardous Materials Identification System".

FLAMMABILITY LIMITS IN AIR:

Much of the information related to fire and explosion is derived from the National Fire Protection Association (**NFPA**). Flash Point - Minimum temperature at which a liquid gives off sufficient vapors to form an ignitable mixture with air. Autoignition Temperature: The minimum temperature required to initiate combustion in air with no other source of ignition. LEL - the lowest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source. UEL - the highest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source.

TOXICOLOGICAL INFORMATION:

Possible health hazards as derived from human data, animal studies, or from the results of studies with similar compounds are presented. Definitions of some terms used in this section are: **LD_{50}** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC_{50}** - Lethal Concentration (gases) which kills 50% of the exposed animals; **ppm** concentration expressed in parts of material per million parts of air or water; **mg/m^3** concentration expressed in weight of substance per volume of air; **mg/kg** quantity of material, by weight, administered to a test subject, based on their body weight in kg. Data from several sources are used to evaluate the cancer-causing potential of the material. The sources are: **IARC** - the International Agency for Research on Cancer; **NTP** - the National Toxicology Program, **RTECS** - the Registry of Toxic Effects of Chemical Substances, **OSHA** and **CAL/OSHA**. IARC and NTP rate chemicals on a scale of decreasing potential to cause human cancer with rankings from 1 to 4. Subrankings (2A, 2B, etc.) are also used. Other measures of toxicity include **TDLo**, the lowest dose to cause a symptom and **TCLo** the lowest concentration to cause a symptom; **TDo**, **LDLo**, and **LDo**, or **TC**, **TCo**, **LCLo**, and **LCo**, the lowest dose (or concentration) to cause lethal or toxic effects. **BEI** - Biological Exposure Indices, represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the TLV. Ecological Information: EC is the effect concentration in water.

REGULATORY INFORMATION:

This section explains the impact of various laws and regulations on the material. **EPA** is the U.S. Environmental Protection Agency. **WHMIS** is the Canadian Workplace Hazardous Materials Information System. **DOT** and **TC** are the U.S. Department of Transportation and the Transport Canada, respectively. Superfund Amendments and Reauthorization Act **(SARA)**; the Canadian Domestic/Non-Domestic Substances List **(DSL/NDSL)**; the U.S. Toxic Substance Control Act **(TSCA)**; Marine Pollutant status according to the **DOT**; the Comprehensive Environmental Response, Compensation, and Liability Act **(CERCLA or Superfund)**; and various state regulations.

APPENDIX B

GEM 2000 Field Calibration and Gas Monitoring Procedures

Table B.1. GEM 2000 Field Calibration Procedures

Project No. 050067, Art Brass Plating, Seattle, WA

Step	Procedure
1	Turn the instrument on by pressing the red button. After the instrument has finished its initial process, the main screen will appear.
2	Press 1 (Menu).
3	Use the Up (2) or Down (8) keys to scroll the field calibration, and then press Enter.
4	Press 3 (Edit) to record target concentrations and manually enter the target concentrations for CH4.
5	Press Enter to move to CO2, and enter the CO2 target concentration.
6	Press Enter to move to O2, and enter the O2 target concentration.
7	Press Enter to complete.
8	Press Enter to go to the calibration menu.
9	Choose Zero Channels.
10	Choose CH4 and connect the gas bottle with 0 % CH4 (i.e., 4 % O2, balance N2).
11	Allow the gas to flow for approximately 30 seconds to ensure a compete purge of any gas in the instrument.
12	Press Enter when done.
13	Press Enter to go to the calibration menu.
14	Choose Zero Channels.
15	Choose O2 and connect the gas bottle with 0 % O2 (i.e., 50 % CH4, 35 % CO2, balance N2).
16	Allow the gas to flow for approximately 30 seconds to ensure a compete purge of any gas in the instrument.
17	Press Enter when done.
18	Press Enter to go to the calibration menu.
19	Choose Span Channels and then press Enter.
20	Choose Span CH4.
21	Verify that the CH4 calibration gas is still connected to the instrument. Wait 30 seconds for the gas to flow through the instrument.
22	Press Enter to set the CH4 span.
23	Press Enter to go to the calibration menu.
24	Choose Span Channels and then press Enter.
25	Choose Span CO2.
26	Verify that the CH4 calibration gas is still connected to the instrument. Wait 30 seconds for the gas to flow through the instrument.
27	Press Enter to set the CO2 span.
28	Press Enter to go to the calibration menu.
29	Connect the gas bottle with 4 % O2 (i.e., 0 % CH4, 0 % CO2, and 4 % O2).
30	Allow the gas to flow for approximately 30 seconds to ensure a compete purge of any gas in the instrument.
31	Choose Span Channels and then press Enter.
32	Select Span O2 and press Enter to set the O2 span.
33	Take a reading from the calibration gas bottles to verify that calibration has been done correctly.

Table B.2. GEM 2000 Gas Monitoring Procedures

Project No. 050067, Art Brass Plating, Seattle, WA

Step	Procedure	Comments
1	Prior to monitoring, check the GEM 2000 internal and external filters, battery status, and calibrating unit.	Record the meter's identification number.
2	Allow the meter infrared (IR) bench to warm up for at least 1 minute.	
3	Check the battery status.	Record the battery status for each set of readings.
4	Read the barometric pressure.	Record the time, date, location, probe ID, and ambient temperature. This information should be entered into meter.
5	Inspect the probe sampling connections for damage.	Record any damage using the GEM 2000 comments section.
6	Connect the meter to the probe using approximately 4 feet of 1/4-inch Teflon tubing and a water trap filter.	Observe the tubing during sampling. Discontinue the sampling procedure if water is seen in the tubing (before reaching filter if possible). Note the presence of water in the probe and pumping duration.
7	Begin pumping. After 2 minutes of purging, record methane, oxygen, and carbon dioxide concentrations at 2-minute intervals over a 10-minute period (six sets of readings). Use UEL or LEL scale as appropriate.	The time needed to evacuate one pore volume is estimated at roughly 30 seconds. A stabilized result should be available within 30 to 45 seconds after the one pore volume. If a switch between UEL and LEL scales is required during sampling, a stabilized result should be available 30 to 45 seconds after pumping restarts.
8	Complete the meter purge cycle before taking the next reading.	

Notes:

LEL lower explosive limit

UEL upper explosive limit