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VOC Emissions from Furniture Products

Customer & Furniture Product Sample Information

Report Certification	
Report number	473-017-01AA-Apr0313
Report date	Apr 3, 2013
Certified by (Name/Title)	Raja S. Tannous, Laboratory Director
Signature	far: I
Date	April 3, 2013

Standards	
Test method	ANSI/BIFMA M7.1-2011 (Furniture & Seating)
Acceptance criteria	ANSI/BIFMA X7.1-2011 + ANSI/BIFMA e3-2012 Sec 7.6.1 & 7.6.2
Modeling scenario	ANSI/BIFMA M7.1 Furniture Item modeled as Open Plan Workstation

Customer Information	
Manufacturer or organization	Intertek
City/State/Country	Kentwood, MI USA
Contact name/Title	Brian Kneibel
Phone number	616-656-1166

Product Sample Information*	
Manufacturer (if not customer)	ConSet A/S
Product name / Number	501-27 Series Electric Height Adjustable Desk / 501-27 8S084
Product CSI category	Office Furniture (12 51 00)
Customer sample ID	I-003135
Manufacturing location	
Date sample manufactured	Jan 14, 2013
Date sample collected	Mar 15, 2013
Date sample shipped	Mar 15, 2013
Date sample received by lab	Mar 20, 2013
Condition of received sample	No observed problems
Lab sample tracking number	473-017-01AA
Test start date and duration	Mar 22, 2013; 7 days (168 hours)

^{*}Chain-of-custody (COC) form for product sample is attached to this report





Conformity Assessment –ANSI/BIFMA X7.1 & ANSI/BIFMA e3 Emission Factor Criteria

VOC Emission Test results: Emission Factor Approach, ANSI/BIFMA X7.1-2011, and ANSI/BIFMA e3-2012, Section 7.6.1 Acceptance Criteria – The results of the test of the individual furniture item or furniture component assembly with respect to the VOC maximum emission factor acceptance criteria for workstations/individual components in the ANSI/BIFMA X7.1-2011 standard for furniture emissions (see Appendix B) and the ANSI/BIFMA e3-2012 Furniture Sustainability Standard, Section 7.6.1 are summarized in Table 1. The pass/fail results are based on the measured VOC emission factors at 168 h for one furniture item (i.e., table, easel, bookcase, etc.) or a furniture component assembly relative to the maximum allowed emission factors for the defined modeling scenario (either open-plan or private office).

Table 1. Pass/Fail conformity based on the VOC emission factor acceptance criteria for workstations/individual components in ANSI/BIFMA X7.1-2011 and ANSI/BIFMA e3-2012, Section 7.6.1

Chemical/Chemical Group	Meets VOC Emission Factor Limit (Pass/Fail)
TVOC	Pass
Formaldehyde	Pass
Total Aldehydes	Pass
4-Phenylcyclohexene (4-PCH)	Pass

VOC Emission Test results: Emission Factor Approach, ANSI/BIFMA e3-2012 Sections 7.6.2 and 7.6.3 Acceptance Criteria – The results of the test of the individual furniture item or furniture component assembly with respect to the individual VOC emission factor acceptance criteria for workstations/individual components in the ANSI/BIFMA e3-2012 Furniture Sustainability Standard, Sections 7.6.2 and 7.6.3 (see Appendices C and D, respectively) are summarized in Table 2. The test results are based on the predicted emission factors of individual VOCs of concern at 336 hour for one furniture item or a furniture component assembly relative to the maximum allowed emission factors for the defined modeling scenario (either open-plan or private office). If formaldehyde is a detected VOC, Table 2 either shows the lowest limit for Section 7.6.2 or 7.6.3 or a non-passing result.

Table 2. Pass/Fail conformity based on the individual VOC emission factor acceptance criteria for workstations/individual components in ANSI/BIFMA e3-2012, Sections 7.6.2 and 7.6.3. Only detected VOCs with acceptance criteria are listed

Chemical	CAS No	Meets VOC Emission Factor Limit (Pass / Fail)
No individual VOCs detected above their quantitation levels		Pass





Test Method for Furniture Product Samples

Test Sample Description – The tested product sample consisted of an electric height adjustable desk base. The unit was assembled in the laboratory, placed inside a mid-scale chamber and tested with all surfaces exposed and a height set to the highest level. A photograph of the tested product sample in the chamber is shown later in this report. The results presented herein are specific to this test item.

Test Protocol Summary - The emission test was performed following ANSI/BIFMA M7.1-2011, "Standard Test Method for Determining VOC Emissions from Office Furniture Systems, Components and Seating." Chemical sampling and analyses were performed following U.S. EPA Compendium Method TO-17 and ASTM Standard Method D 5197. The product sample was placed directly into the chamber and maintained at controlled conditions for 7 days (168 h). The chamber conditions for the test period are summarized in Table 3. Air samples were collected from the chamber prior to the test (background or 0 h) and at 72 h and 168 h after initiating the test. The 72-h and 168-h samples were collected in duplicate. Samples for the analysis of individual VOCs and TVOC were collected on multisorbent tubes containing Tenax-TA backed by a carbonaceous sorbent. Samples for the analysis of low molecular weight aldehydes were collected on treated DNPH cartridges. VOC samples were analyzed by thermal desorption GC/MS. TVOC was calculated using toluene as the calibration reference. Individual VOCs (iVOCs) were quantified using multi-point (4 or more points) calibration curves prepared with pure standards, unless otherwise noted. Individual VOCs without pure standards were quantified based on their total-ion-current responses using toluene as the calibration reference. Formaldehyde and acetaldehyde were analyzed by HPLC and quantified using multi-point (4 or more points) calibration curves. Total aldehydes were calculated as the sum of the ppb concentrations of individual aldehydes determined by HPLC and GC/MS. The analytical instruments and their operating conditions are described in Appendix A.

Availability of Data – All data, including but not limited to raw instrument files, calibration files, and quality control checks used to generate the test results will be made available to the customer upon request.

Table 3. Chamber conditions for test period

Parameter	Symbol	Units	Value
Number of specimen units	Ns		1
Chamber volume	V _C	m³	13.33
Avg. Inlet gas flow rate	Qc	m³/h	6.162
Ventilation rate	a _C	h ⁻¹	0.46 ± 0.03
Avg Temperature & Range		°C	22.8 (22-24)
Avg Relative humidity & Range		%	50 (45-55)
Chamber Pressure		Pa	10
Duration		h	168

^{*}ANSI/BIFMA M7.1-2011, EPA Method TO-17, and ASTM Standard Method D 5197 are included in Berkeley Analytical's scope of ISO/IEC17025 accreditation, Testing Laboratory TL-383, International Accreditation Service, www.iasonline.org





VOC Emission Test Results

Chamber Back round Concentrations – Background concentrations measured at time zero are reported in Table 4. The background concentrations of TVOC, formaldehyde, acetaldehyde, 4-phenylcyclohexene, and reported iVOCs are listed.

Table 4. Chamber background VOC concentrations at time zero

Chemical/Chemical Group	CAS No	Chamber Conc (µg/m³)
Acetaldehyde	75-07-0	LQ
Formaldehyde	50-00-0	LQ
4-Phenylcyclohexene	4994-16-5	LQ
TVOC		LQ

Emitted VOCs – Individual VOCs (iVOCs) detected in the test and present above the lower limits of quantitation in chamber air are reported in Table 5. All iVOCs with CRELs and/or on other lists of toxicants of concern are listed first. Next, all frequently occurring iVOCs with pure standard calibrations are listed. Additionally, the 10 most abundant iVOCs quantified using toluene as the reference standard are listed; identifications of these compounds are considered tentative. Reporting of fewer than 10 iVOCs indicates that fewer than 10 chemicals met these criteria.

Table 5. VOCs detected above lower limits of quantitation in air samples at 72 and/or 168 hours

Chemical	CAS No	Surro ate?*	CREL (µg/m³)	CARB TAC Cate ory	Prop 65 List?
Acetic acid	64-19-7	Yes			

^{*&}quot;Yes" response indicates iVOC quantified using toluene as the calibration reference; all other iVOCs quantified using pure standards





Table 6. Measured chamber concentrations of chemicals/chemical groups specified in ANSI/BIFMA X7.1-2011 and ANSI/BIFMA e3-2012, Section 7.6.1. Aldehydes are listed individually

		72-hour Air Samples (μg/m³)					168-hour Air Samples (μg/m³)				
Chemical/Chemical Group	CAS No	Chamber Conc #1	Chamber Conc #2	Average Conc	Rel Diff %	Chamber Conc #1	Chamber Conc #2	Average Conc	Rel Diff %		
TVOC		LQ	LQ	LQ	na	LQ	LQ	LQ	na		
Formaldehyde	50-00-0	LQ	LQ	LQ	na	LQ	LQ	LQ	na		
4-Phenyicyclohexene	4994-16-5	LQ	LQ	LQ	na	LQ	LQ	LQ	na		





Table 7. Measured chamber concentrations of iVOCs specified in ANSI/BIFMA e3-2012, Section 7.6.2

		72-hour Air Samples (μg/m³)				168-hour Air Samples (μg/m³)			m³)
Chemical	CAS No	Chamber Conc #1	Chamber Conc #2	Average Conc	Rel Diff %	Chamber Conc #1	Chamber Conc #2	Average Conc	Rel Diff %
Acetic acid	64-19-7	2.5	3.5	3.0	33.3*	LQ	LQ	LQ	na

^{*}Relative difference between samples #1 and #2 exceeds 15%





Table 8. Calculated emission factors (EFs) for chemicals/chemical groups specified in ANSI/BIFMA X7.1-2011 and ANSI/BIFMA e3-2012, Section 7.6.1. Aldehydes are listed individually

Chemical/Chemical Group	CACNA	EF (μg	/unit-h)	Power Law Model*		
	CAS No	72 h	168 h	Coef 'a'	Coef 'b'	
TVOC		LQ	LQ	na	na	
Formaldehyde	50-00-0	LQ	LQ ·	na	na	
4-Phenylcyclohexene	4994-16-5	LQ	LQ	na	na	

^{*}Calculated by ANSI/BIFMA M7.1-2011, Equations 11.7 and 11.8





Table 9. Calculated emission factors (EFs) for iVOCs specified in ANSI/BIFMA e3-2012, Section 7.6.2

Chemical	CACNA	EF (μg/unit-h)		Power Law Model*	
Criemical	CAS No	72 h 168 h		Coef 'a'	Coef 'b'
Acetic acid	64-19-7	18.6	LQ	na	na

^{*}Calculated by ANSI/BIFMA M7.1-2011, Equations 11.7 and 11.8





Table 10. Calculated emission factors for individual and total aldehydes at 72 and 168 hours (molar basis)

Chemical	CACNO	MW	Emission Factor (µmol/unit-h)		
Chemicai	CAS No.	IVIVV	72 h	168 h	
No individual aldehydes detected above their quantitation levels			LQ	LQ	

Table 11. Emission factors of iVOCs including those specified in ANSI/BIFMA e3-2012, Section 7.6.2, for tested furniture item or component assembly projected to 336 h

Chemical	CAS No	Projected Emission Factor (µg/unit-h)*	
		336 h	
Acetic acid	64-19-7	LQ	

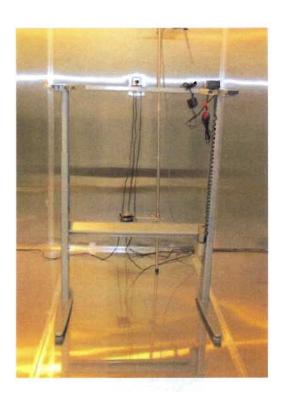
^{*}If power law "b" coefficient is outside the range -0.15<b<0.15, Eq. (2) under "Equations and Comments" is used to estimate the 336-h value; if the "b" coefficient is within the range -0.15<b<0.15, the average of the 72-h and 168-h emission factors in Table 9 is used to estimate the 336-h value





Photographs of Tested Furniture Item or Component Assembly Product

Photo Documentation – A furniture item is photographed after it is loaded into a mid-scale chamber and immediately prior to initiating the test. A component assembly is photographed after preparation of the test specimen and immediately before loading the specimen into a small-scale chamber.







Definitions

Table 12. Definitions of parameters

Parameter/Value	Definition
CARB TAC	Toxic Air Contaminant (TAC) on California Air Resources Board list, with toxic category indicated
CAS No.	Chemical Abstract Service registry number providing unique chemical ID
Chamber Conc.	Measured chamber VOC concentration at time point minus any analytical blank or background concentration for empty chamber measured prior to test. Lower limit of quantitation (LQ) or reporting limit for individual VOCs is 2 μg/m ³ unless otherwise noted
CREL	Chronic non-cancer Reference Exposure Level established by Cal/EPA OEHHA (http://www.OEHHA.ca.gov/air/allrels.html)
Emission Factor	Mass of compound emitted per area (or unit) per hour (calculation shown below). Reporting limits for emission factors are established by LQ or reporting limit for chamber concentration and tested sample area (or number of tested units for unit specific emission factor)
Formaldehyde & acetaldehyde	Volatile aldehydes quantified by HPLC following ASTM Standard Method D 5197. LQs for formaldehyde and acetaldehyde are 0.8 µg/m³ and 1.1 µg/m³, respectively
Individual VOCs	Quantified by thermal desorption GC/MS following EPA Method TO-17. Compounds quantified using multi-point calibrations prepared with pure chemicals unless otherwise indicated. VOCs with chronic RELs are listed first, followed by other TAC and Prop. 65 compounds. Additional abundant VOCs at or above reporting limit of 2 µg/m ³ are listed last
LQ	Indicates calculated value is below its lower limit of quantitation
Prop 65 list	"Yes" indicates the compound is a chemical known to cause cancer or reproductive toxicity according to California Safe Drinking Water Toxic Enforcement Act of 1986 (Proposition 65)
Total aldehydes	Sum of the parts-per-billion concentrations of formaldehyde and acetaldehyde determined by HPLC and all other individual aldehydes determined by GC/MS
TVOC	Total Volatile Organic Compounds eluting over retention time range bounded by n-hexane and n-hexadecane and quantified by GC/MS TIC method using toluene as calibration reference. LQ for TVOC is 20 µg/m ³
"na"	Not applicable
"<"	Less than value established by LQ





Equations and Comments

Equations Used in Calculations – An emission factor (EF) in μ g/unit-h for a chemical in a chamber test of a workstation furniture component is calculated using Equation 1:

$$EF = (Q (C - C_0)) / N_s$$
 (1)

where Q is the chamber inlet air flow rate (m^3/h), C is the VOC chamber concentration ($\mu g/m^3$), C_0 is the corresponding chamber background VOC concentration ($\mu g/m^3$), and N_s is the number of tested units.

For decaying or increasing sources, the predicted VOC emission factor at 336 h is calculated by:

$$E(t) = at^{-b}$$
 (2)

Where E(t) is the predicted emission factor at time t in μ g/(unit-h) or μ g/(m²-h) for unit and area sources, respectively; t = 336 h; a = coefficient from Eq. 11.8, ANSI/BIFMA M7.1-2011; and b = coefficient from Eq. 11.7 (*ibid*.). Note that for decaying sources, the report tables show a positive "b" value (the "negative" sign is applied in Eq. 2). Conversely, for increasing sources, the report tables show a negative "b" value.

Comments: The given emission factors were calculated per one unit. The dimensions of the desk base are 83.5 cm by 45.0 cm by 117.0 cm (W/D/H). Sample was received at the laboratory outside the required timeline.

END OF REPORT





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Appendix A Analytical Instruments Operatin Parameters

Table A1. Description of analytical instrument components

Component	Description				
HPLC	1260 Infinity Quaternary LC, G1314F VW Detector, Agilent				
Analytical column	Poroshell 120 EC-C18, Agilent				
Column dimensions	2.1 mm x 100 mm				
Thermal desorber	Unity / UltrA TD, Markes International, Ltd.				
Gas chromatograph	Model 6890N, Agilent				
Analytical column	DB-1701, J&W Scientific				
Column dimensions	1 μm film, 0.25 mm ID, 30 m				
Mass spectrometer	Model 5973N MSD, Agilent				

Table A2. HPLC operating parameters for analysis of formaldehyde and acetaldehyde

Parameter	Value
Solvent A	65/35% H₂O/Acetonitrile
Solvent B	100% Acetonitrile
Flow rate	0.3 mL/min
End time	11 min
Detector wavelength	360 nm

Table A3. Thermal desorption GC/MS parameters used for analysis of iVOCs and TVOC

Parameter	Value
Thermal desorption	
Tube desorb temperature	285 °C
Trap temperature	~5 °C
Trap desorb temperature	300 °C
Trap desorb split ratio	2:1
Gas chromatograph	
Initial temperature	1°C
Initial temperature time	6.5 min
Temperature ramp rate 1	5°C/min
Final temperature 1	100 °C
Temperature ramp rate 2	12 °C /min
Final temperature 2	225 °C
Final temperature 2 time	2 min
Mass spectrometer	
Low scan mass, /z	30 amu
High scan mass, /z	450 amu
Scan rate	0.5 Hz





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Appendix B

Copied from ANSI/BIFMA X7.1-2011, Standard for Formaldehyde and TVOC Emissions of Low-emittin Office Furniture and Seatin

Table A1.2
Workstation or Individual Furniture Components Maximum Emission Factors*

Chemical/Chemical Group	ANSI/BIFMA M7.1 Open Plan Office environment	ANSI/BIFMA M7.1 Private Office environment	
Formaldehyde (µg/m²-h)	42.3	85.1	
TVOC (μg/m²-h)	345	694	
Total Aldehydes (μmol/m²-h)	2.8	5.7	
4-Phenylcyclohexene (μg/m²-h)	4.5	9.0	

^{*}Based on open plan and private office workstations defined in ANSI/BIFMA M7.1-2011





Appendix C

Copied from ANSI/BIFMA e3-2012 Furniture Sustainability Standard Annex C – Individual Volatile Or anic Chemical (VOC) Concentration Limits (Normative see Section 7.6.2)

				Workstation	Seatin	Individual Components	
Compound Name	CASRN	MW	CREL	Maximum Allowable Conc. (μg/m³)	Maximum Allowable Conc. (μg/m³)	Open Plan Maximum Allowable Emission Factor (μg/m²h)	Private Office Maximum Allowable Emission Factor (μg/m²h)
Ethylbenzene	100-41-4	106.2	Υ	1000	500	689	1392
Styrene	100-42-5	104.2	Υ	450	225	310	627
1,4-Dichlorobenzene	106-46-7	147	Υ	400	200	276	557
Epichlorohydrin	106-89-8	92.52	Υ	1.5	0.75	1	2.1
Ethylene Glycol	107-21-1	62.1	Υ	200	100	138	278
1-Methoxy-2-propanol	107-98-2	90.12	Υ	3500	1750	2413	4874
Vinyl Acetate	108-05-4	86.1	Υ	100	50	68.9	139
Toluene	108-88-3	92.1	Y	150	75	103	209
Chlorobenzene	108-90-7	112.56	Υ	500	250	345	696
Phenol	108-95-2	94.1	Υ	100	50	68.9	139
2-Methoxyethanol	109-86-4	76.1	Υ	30	15	21	42
Ethylene glycol monomethyl ether acetate	110-49-6	118.13	Y	45	22.5	31	63
n-Hexane	110-54-3	86.2	Y	3500	1750	2413	4874
2-Ethoxyethanol	110-80-5	90.1	Υ	35	17.5	24	49
2-Ethoxyethyl acetate	111-15-9	132.2	Υ	150	75	103	209
1,4-Dioxane	123-91-1	88.1	Y	1500	750	1034	2089
Tetrachloroethylene	127-18-4	165.8	Υ	17.5	8.75	12.1	24.4
Formaldehyde	50-00-0	30.1	Υ	16.5	8.25	11	23
Isopropanol	67-63-0	60.1	Y	3500	1750	2413	4874
Chloroform	67-66-3	119.4	Υ	150	75	103	209
N,N-Dimethyl Formamide	68-12-2	73.09	Y	40	20	28	56
Benzene	71-43-2	78.1	Υ	30	15	21	42
1,1,1-Trichloroethane	71-55-6	133.4	Υ	500	250	345	696
Acetaldehyde	75-07-0	44.1	Y	70	35	48	97
Methylene Chloride	75-09-2	84.9	Υ	200	100	138	278
Carbon Disulfide	75-15-0	76.14	Υ	400	200	276	557
Trichloroethylene	79-01-6	131.4	Υ	300	150	207	418
1-Methyl-2- Pyrrolidinone	872-50-4	99.13	N	160	80	110	223
Naphthalene	91-20-3	128.2	Υ	4.5	2.25	3	6
Xylenes (m-, o-, p-Xylene	108-38-3 95-47-6	106.2	Υ	350	175	241	487
combined)	106-42-3	100.2			1/3	241	407





Appendix D

ANSI/BIFMA e3-2012 Furniture Sustainability Standard Section 7.6.3

Low Emittin Furniture Formaldehyde Credit

				Workstation	Seatin	Individual (Components
Compound Name	CASRN	MW	CREL	Maximum Allowable Conc. (μg/m³)	Maximum Allowable Conc. (μg/m³)	Open Plan Maximum Allowable Emission Factor (µg/m²h)	Private Office Maximum Allowable Emission Factor (µg/m²h)
Formaldehyde	50-00-0	30.1	Υ	9	4.5	6.2	12.5

berkeley (analytical

Ship to: 815 Harbour Way South, No. 6 Richmond, CA 94804-(Ph) 510-236-2325, (Fx) 510-236-2335 info@berkeleyanalytical.com

Customer Information* Company: Interlek Street Address: 4700 Broadmoor Ave Ste 200

City/State/Zip(postal code): 49512 Country: United States

Contact Name & Title (for reporting). Brian Kneibel

Contact Phone/Fax Numbers: 616-656-1166

Contact E-mail Address: bnan kneibel@intertek.com

Financially Responsible Co. (if different):

Manufacturer Information (if different from customer)

Company: ConSet NS

City/State/Country: Skjern Denmark

Contact Name/Title: Michael Overgaard, Managing Director

Phone Number/E-mail Address: mo@conset.com

Sample Details

Product Commercial Name*: 501-27 Series Electric Height Adjustable Desk

Product Commercial Part No. (if not part of the name)*: 501-27 8S084

Manufacturer Sample Tracking ID: 1-003135

Date Manufactured* 1/14/2013

Product Category & Use*. Electric Height Adjustable Desk

Sample Construction Material*: Steel, motor and electronics

Plant Name & Location"

Collection Location within Plant: ConSet America , Pittsboro NC Warehouse:

Date & Time Collected*: 03/15/2013

Number of Sample Pieces*: 1 Unit (2pcs) Photo(s) of Collection Location: Attach

Sample Collected by": Mark Fink

Phone/Fax Numbers*: P800-293-9051 F919-542-2727

E-mail Address* markf@consetus

Shipping Details*

Packed & Shipped By: Patty Laws

Shipping Date: 03/15/2013

Carrier/Airbill Number: 1Z7F2R300200071445

Chain of Custody for Furniture Product VOC Emission Test

A Separate COC must be completed for EACH product/material sample

A link to Berkeley Analytical's Terms & Conditions is included in this workbook. By submitting samples,

customer acknowledges and accepts these terms 3 conditions unless a prior written contract is in effect.

Berkeley Analytical Quotation Number:

Purchase Order (enter company & number):

Requested Tost (automatically filled from FurnitureWorksheet Selections)

BIFMA M7.1-2011 (small-scale chember), compliance Test to be performed

Type of furniture product Workstallon component

Target chemicals and chemical groups Formaldehyde, total aldehydes, TVOC, individual VDCs

Modeling scenario Best fit workstation model based on emission results.

Test schedule (for screening tests only)

Test results application(s)

For Berkeley Analytical Use:

Report ID

Billing Reference

187779 or 80



Customer Instructions for Sample Prop., Yest Type, Schedule, etc. (filled from FurnitureWorksheet)

Test sample at miclocale chamber per Al's instruction. A

Customer Request for Laboratory Certificate of Compliance

Indicate if you are ordering a Laboratory Certificate of Compliance:

Laboratory certificates are evailable for the compliance test(s) listed on the FurnitureWorksheet. Berkeley Analyticat's laboratory test results and associated certificates are specific to the tested item. Claims made by the customer regarding the broader representativeness of the test results and certificate are the sole responsibility of the customer.

Customer Authorizes Laboratory to Submit Copies of Test Report to:

Contact/E-mail Address: Mark Fink markf@conset.us

Organization: ConSet America

Contact/E-mail Address: Chris Maas chrismaas@carolina.rr.com

Organization: Contract Furniture Sales Management

for Berkoley Analytical Use Only

Condition of Shipping Package:

Condition of Sample:

Lab Tracking Number:

473-017-DIAA

Sample Handling				
Relinquished By*	Received By*	Signature*	Date*	Company*
				No.
	ALEC HUBNG	Alex Hus	ans 3/20/2012 BKF	