RD
Contractor: UC, Irvine
Contract # 08-317

FUNDING FISCAL YEAR	FY 08/09	FY 09/10	FY 10/11	
TERM	06/30/09-12/01/11	06/30/09-12/01/11	06/30/09-12/01/11	
PCA	72380	72380	72380	
LINE ITEM/OBJECT	398	398	398	TOTAL
DESCRIPTION				
Contract $	313,219.00	89,491.00	44,746.00	447,456.00
				-
				-
Total, Contract	313,219.00	89,491.00	44,746.00	447,456.00

Payments to Contractor:

Inv. #	Inv. Date	Ser Per				C/S
						-
						-
						-
						-
						-
						-
						-
						-
						-
						-
						-
						-
						-
						-
						-
						-
						-
						-
Total, Payments			-	-	-	-
Balance Available to Pay Contractor			313,219.00	89,491.00	44,746.00	447,456.00
Balance Must Be Spent By:			*06/30/11*	*06/30/12*	*06/30/13*	

Notes:

Contract Manager: Tony VanCuren

56

W:\Contracts\ARB\FY 08-09\08-317m UC Irvine.xls
11/19/2009

STATE OF CALIFORNIA
STD 213 (Rev 06/03)

AGREEMENT NUMBER
08-317
REGISTRATION NUMBER

1. This Agreement is entered into between the State Agency and the Contractor named below:

STATE AGENCY'S NAME
Air Resources Board (ARB or State)

CONTRACTOR'S NAME
The Regents of the University of California, Irvine (UCI, University, or Contractor)

2. The term of this Agreement is: June 30, 2009 through December 11, 2011

3. The maximum amount of this Agreement is: **$447,456.00** (Four Hundred Forty-Seven Thousand Four Hundred Fifty-Six Dollars and no Cents)

4. The parties agree to comply with the terms and conditions of the following exhibits which are by this reference made a part of the Agreement.

Exhibit A – Scope of Work	1 Page
Exhibit A, Attachment 1 -- Proposal	37 Pages
Exhibit B – Budget Detail and Payment Provisions	2 Pages
Exhibit B, Attachment 1 – Budget Detail	14 Pages
Exhibit C* – General Terms and Conditions	GIA 101
Check mark one item below as Exhibit D:	
[X] Exhibit D - Special Terms and Conditions (Attached hereto as part of this agreement)	1 Page
[ ] Exhibit D*- Special Terms and Conditions	
Exhibit E – Additional Provisions	4 Pages
Exhibit F – Research Final Report Format	7 Pages

Items shown with an Asterisk (*), are hereby incorporated by reference and made part of this agreement as if attached hereto. These documents can be viewed at www.ols.dgs.ca.gov/Standard+Language

IN WITNESS WHEREOF, this Agreement has been executed by the parties hereto.

CONTRACTOR

CONTRACTOR'S NAME *(if other than an individual, state whether a corporation, partnership, etc.)*
The Regents of the University of California, Irvine

BY *(Authorized Signature)* — DATE SIGNED *(Do not type)* 7/29/09

PRINTED NAME AND TITLE OF PERSON SIGNING
Kevin Chamness
Principal Contract & Grant Officer

ADDRESS
Office of Research, 300 University Towers
Irvine, CA 92697-7600

STATE OF CALIFORNIA

AGENCY NAME
Air Resources Board

BY *(Authorized Signature)* — DATE SIGNED *(Do not type)* AUG 06 2009

PRINTED NAME AND TITLE OF PERSON SIGNING
Socorro Watkins, Chief, Business Management Branch

ADDRESS
1001 I Street, 20th Floor
Sacramento, CA 95814

Sharon Simmons
Contract Services Section Manager
Air Resources Board

California Department of General Services Use Only

APPROVED
AUG 19 2009
DEPT OF GENERAL SERVICES

☐ Exempt per:

Linda S. Adams
Secretary for Environmental Protection

Air Resources Board

Mary D. Nichols, Chair
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Arnold Schwarzenegger
Governor

TO: K. Michelle Livsey, Senior Staff Counsel
Office of Legal Services
Department of General Services
707 Third Street, 7th Floor
West Sacramento, CA 95605

FROM: Dory Kramer, Contract Analyst
Air Resources Board
Contract Services Section

DATE: August 6, 2009

SUBJECT: REQUEST FOR APPROVAL OF CONTRACT NO. 08-317 WITH THE REGENTS OF THE UNIVERSITY OF CALIFORNIA, IRVINE (UCI).

Enclosed please find the following documents for your review and approval relating to the above referenced agreement.

Std. 215	1 original and 1 copy
Std. 213	2 original face sheets (signed and counter-signed) 1 copy face sheet 1 copy face sheet w/ complete agreement
Back-Up Docs	Agency Attestation Memo. Prepayment for Interagency Memo. Late Justification Memo.

If you have any questions, please contact me at 916 / 445-4444 or via email at dkramer@arb.ca.gov.

Thank you,

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our website: http://www.arb.ca.gov.

California Environmental Protection Agency

Printed on Recycled Paper

University Agreement Terms and Conditions

EXHIBIT A

SCOPE OF WORK

1. The Regents of the University of California, Irvine (UCI, University, or Contractor) agrees to provide the following services for the project entitled "Airborne and Ground Based Whole Air Sampling during CalNex 2010," which is attached hereto as Exhibit A, Attachment 1 and made a part of this Agreement.

2. Term: The term of this agreement is June 30, 2009 through December 11, 2011; however no work shall commence until receipt of final approval from the Department of General Services (DGS). Consequently, all dates contained in the Exhibits and Attachments shall be considered revised to conform to the actual term of this agreement, and the schedule shall not begin until Contractor receives written notice from ARB of final approval by DGS.

3. The project representatives during the term of this agreement will be:

Requesting Agency: ARB	**Providing Agency: UCI**
Name: James Pederson	Name: Donald Blake
Division/Department: Research Division	Division/Department: Dept. of Chemistry
Phone: 916-322-7221	Phone: 949-824-4195
Fax: 916-322-4357	Fax: n/a
Email: jrpeders@arb.ca.gov	Email: drblake@uci.edu

The ARB Contract Administrator is: The University's Contract Administrator is:

Requesting Agency: ARB	**Providing Agency: UCI**
Name: Sally Jorgensen	Name: Tam Tran
Division/Office: Research Division	Division/Office: Office of Research
Address: 1001 "I" Street, 5th Floor Sacramento, CA 95814	Address: 300 University Tower Irvine, CA 92697-7600
Phone: 916-327-1500	Phone: 949-824-7813
Fax: 916-322-4357	Fax: n/a
Email: sjorgens@arb.ca.gov	Email: tamkt@rgs.uci.edu

TECHNICAL PROPOSAL

Airborne and Ground-Based Whole Air Sampling During CalNex 2010

Principal Investigator:
Donald R. Blake

Official Authorized to Bind this Proposal:
Judith Aguirre

Signature _____

Prepared for:

State of California Air Resources Board
Research Division
P.O. Box 2815
Sacramento CA 95812-2815

Prepared by:

University of California, Irvine
Department of Chemistry
573 Rowland Hall
Irvine, CA 92697-2025
(949) 824-4195

November 24, 2008

Check if applicable:
Animal subjects _____
Human subjects _____

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1. TECHNICAL PROPOSAL

1.1 Statement of Significance

Air quality in California has improved considerably in the past three decades as a result of a highly effective air pollution control program. Despite these improvements air quality continues to be a challenge in this state, owing to topography, population, and climate (www.arb.ca.gov). In addition, California is a leading global emitter of carbon dioxide (CO_2). The CalNex 2010 project seeks to better understand the sources and distributions of air pollutants over California and the Eastern Pacific, including primary trace gases such as CO_2 and secondary gases such as ozone (O_3), itself a greenhouse gas that is produced by the photochemical reactions of volatile organic compounds (VOCs) and nitrogen oxides (NO_x) in the presence of sunlight. The results from CalNex 2010 will be used to provide scientific information to policy makers in their effort to determine contemporary strategies to enhance air quality and mitigate climate change.

Our group at UC-Irvine has more than three decades of experience in the measurement of key contributors to air quality and climate change. During CalNex 2010 we propose to measure critical trace gases that directly and indirectly impact air quality and climate change, including carbon monoxide (CO) and more than 60 C_1-C_{10} VOCs. More than 1000 whole air samples will be collected from both airborne and ground-based platforms and analyzed at our UC-Irvine laboratory, which specializes in highly sensitive, speciated trace gas measurements using gas chromatography. This comprehensive suite of VOCs is critical for three reasons:

(1) The VOC measurements will characterize the ambient levels and the local and regional distributions of key atmospheric traces gases over California in 2010, both at ground level and at higher altitudes. These data will highlight any hotspot emission regions and can subsequently be used by modelers for "bottom up" and "top down" emission estimate calculations.
(2) As has been demonstrated in numerous prior field missions, our measurements are ideal for correctly pinpointing the origin (source), transport pathway, and "age" of the sampled air masses. In addition, our measurements are critical for the correct interpretation of the direct observations of climatically relevant trace gases (e.g., CO_2 and CH_4). Correlations among the wide range of different species that we measure will provide constraints on their sources, which will also help to constrain top-down model estimates of their emissions.
(3) The VOC measurements allow photochemical ozone creations potentials to be calculated, which in turn indicate which VOCs are the leading contributors to O_3 formation within a sampled air mass.

The measurements and analysis that we propose during CalNex 2010 are directly relevant to the objectives of the Air Resources Board. The compounds that we measure directly impact the radiative forcing of the atmosphere, stratospheric O_3 depletion, and local and regional air quality. Therefore we expect our participation in CalNex 2010 to make a major contribution in furthering our understanding of the Californian atmospheric environment and the processes that impact climate and air quality in this region.

1.2 Abstract

The CalNex 2010 mission seeks to better understand the interactions between air quality and climate change, in particular as it relates to California and the surrounding region. Volatile organic compound (VOC) measurements are a key component of any comprehensive air quality and climate assessment. To this end, UC-Irvine proposes to perform comprehensive whole air sampling and analysis during the CalNex 2010 field mission. A maximum of 72 whole air sampling canisters will be filled per flight of the NOAA WP-3 aircraft, and the airborne sampling will be coordinated by our colleague Elliot Atlas. The total number of samples collected will depend on the number of flights. Our group will simultaneously collect ground-level whole air samples throughout California. We will collect 100-200 whole air samples in San Francisco and in Los Angeles, and an additional 100-200 whole air samples in the San Joaquin Valley.

For each whole air sample that is collected, more than 60 trace gases will be identified and quantified at our Irvine laboratory, including C_2-C_{10} NMHCs, C_1-C_2 halocarbons, C_1-C_5 alkyl nitrates, and selected sulfur compounds. The analysis will be performed using gas chromatography (GC) together with flame ionization detectors (FIDs, sensitive to hydrocarbons), electron capture detectors (ECDs, sensitive to halocarbons and organic nitrates), and a mass spectrometer detector (MSD, for unambiguous compound identification). The resulting data will be of the highest quality. Each peak from every chromatogram will be individually inspected, and each resulting trace gas mixing ratio will be carefully calibrated and assessed. All data will be archived in a timely fashion and made available to our CalNex colleagues.

These data will be applied to a number of CalNex 2010 objectives. (1) The data can be used to characterize the ambient levels and distributions of key VOCs in and around California. (2) Our numerous previous studies have repeatedly demonstrated the power of nonmethane hydrocarbon and halocarbon measurements to correctly diagnose sources and transport pathways in the atmosphere. During CalNex 2010 we will use our data to determine the origins, "age", and transport pathways of pollution to and within California. (3) The VOCs that we measure are precursors to ground-level ozone (O_3). These data can be used to calculate photochemical ozone creation potentials, which in turn will inform us as to which VOCs are the leading contributors to O_3 formation in California. Together, these results will provide decision makers with the scientific information they require to create effective, targeted strategies for improving air quality and reducing greenhouse gas emissions in California.

Our group has extensive prior experience in airborne and ground-based field missions and we expect our participation in CalNex 2010 to make an essential contribution to the overall success of the mission. Data such as those which we propose to collect during CalNex 2010 have already made highly successful contributions to our understanding of changes in the composition and chemistry of the atmosphere. Therefore, we expect our participation in the project to have a major impact on furthering our understanding of sources and atmospheric processes responsible for the emission of greenhouse gases and the production of ozone in California.

1.3 Project Objectives

The CalNex 2010 program broadly seeks "to study the important issues at the nexus of the air quality and climate change problems, and to provide scientific information regarding the trade-offs faced by decision makers when addressing these two inter-related issues" (CalNex 2010 White Paper). In support of CalNex 2010, our group proposes to meet the following research objectives:

1. Provide high quality measurements of individual volatile organic compounds (VOCs) that are central to air quality and climate change, namely methane (CH_4), carbon monoxide (CO), selected C_2-C_{10} hydrocarbons, C_1-C_2 halocarbons, C_1-C_5 alkyl nitrates and C_1-C_2 sulfur compounds. This will be achieved using our established techniques of airborne and ground-based whole air sampling followed by laboratory analysis using gas chromatography (GC) with flame ionization detection (FID), electron capture detection (ECD), and mass spectrometric detection (MSD).

2. Assess our data within the framework of the CalNex 2010 objectives.

   (2a) The VOC measurements will characterize the ambient levels and local and regional distributions of key atmospheric traces gases over California in 2010, both at ground level and at higher altitudes. These data will highlight any hotspot emission regions and can subsequently be used by modelers for "bottom up" and "top down" emission estimate calculations.

   (2b) As has been demonstrated in numerous prior field missions, our measurements are ideal for correctly pinpointing both the origin (source), transport pathway, and "age" of the sampled air masses. In addition, our measurements are critical for the correct interpretation of direct observations of climatically relevant trace gases (e.g., CO_2 and CH_4). Correlations among the wide range of different species that we measure will provide constraints on their sources, which will also help to constrain top-down model estimates of their emissions.

   (2c) The VOC measurements allow photochemical ozone creations potentials to be calculated, by which it can be determined which VOCs are the leading contributors to O_3 formation within California.

3. Analyze, archive and publish our data in a timely manner, and fully participate in meetings and conferences.

4. Provide decision makers with scientific information and assessments from which they can develop effective strategies for improving air quality in California and reducing greenhouse gas emissions.

1.4 Technical Plan

1.4.1 Experimental Techniques

During CalNex 2010 our colleague Prof. Elliot Atlas (University of Miami) will collect:

(1) Airborne whole air samples aboard the NOAA WP-3 aircraft.

My group will collect:

(2) Coordinated ground-level samples at the same time as selected flighst deploying from California; and

(3) Urban ground-level samples in greater Los Angeles and San Francisco.

All of the samples (both airborne and ground-based) will be analyzed at my group's laboratory at UC-Irvine. As in previous missions some canister samples will undergo follow-up analysis by Elliot Atlas at his University of Miami laboratory for intercomparison purposes. The final canister data submitted for use by other groups will be UC-Irvine data.

Airborne and Ground-Level Whole Air Sampling

Airborne samples. Prof. Elliot Atlas will collect 72 whole air samples per flight aboard the NOAA WP-3. We will use conditioned, evacuated 1.4-L stainless steel canisters that have been specifically designed for this purpose. The canisters are linked in groups of 12 and are automatically opened by pressing a designated computer button (Figure 1). The sampling interval will depend on the duration of the flight. For example an 8-hour flight allows a sample to be collected every 6-7 minutes, and a 6-hour flight allows a sample every 5 minutes. The fill-time of the sampling canisters is flexible but is usually about one minute. The exact timing of sample collection will be determined by Elliot Atlas based on each flight's science objectives and the specific air masses that are encountered. Sample collection on board the aircraft will be coordinated with other experiments and any intercomparison activities, so as to optimize sample overlap with other groups.

Our aircraft requirements are as follows. We require space for a rack containing a gas handling manifold and 6 sets of 12 linked 1.4-L stainless steel samplings canisters (100 lbs), plus a pump (60 lbs, 60 Hz power) and various tools (40 lbs). A window mounted ¼" forward-facing inlet and an aft-facing outlet are also required. A minimum of 36" clearance is required in front of the canisters in order to allow full access during the exchange of filled canisters with empty ones.

Currently we have 20 sets of 12 canisters, or enough for 3 consecutive flights before we need to re-use cans. We anticipate that an additional 6 sets of 12 canisters will be fabricated before 2010, which would relax the required turnaround time for the canisters. Depending on where the NOAA WP-3 is based during the mission, we will either privately drive the canisters to and from the airport, or else ship them by courier.

Ground-level samples. In addition to airborne sampling we propose to collect 100-200 ground-level samples in the San Joaquin Valley in coordination with WP-3 flights over this region, similar to the grid sampling we did in March 2008 during ARCTAS-California (Section 1.4.2). The samples will be collected in conditioned, evacuated 2-L stainless steel canisters, similar to those used for airborne sampling. Each canister is equipped with a bellows valve, and a sample is collected by opening the valve after allowing a small volume of headspace air to equilibrate

with the local atmosphere. As with the airborne sampling, the canister fill-time is flexible and is usually chosen to be one minute. We also propose to collect 100-200 urban samples in each of greater Los Angeles and San Francisco (Section 1.4.2). These samples will be used to characterize the chemical signatures of these major urban centers of California as observed in 2010.

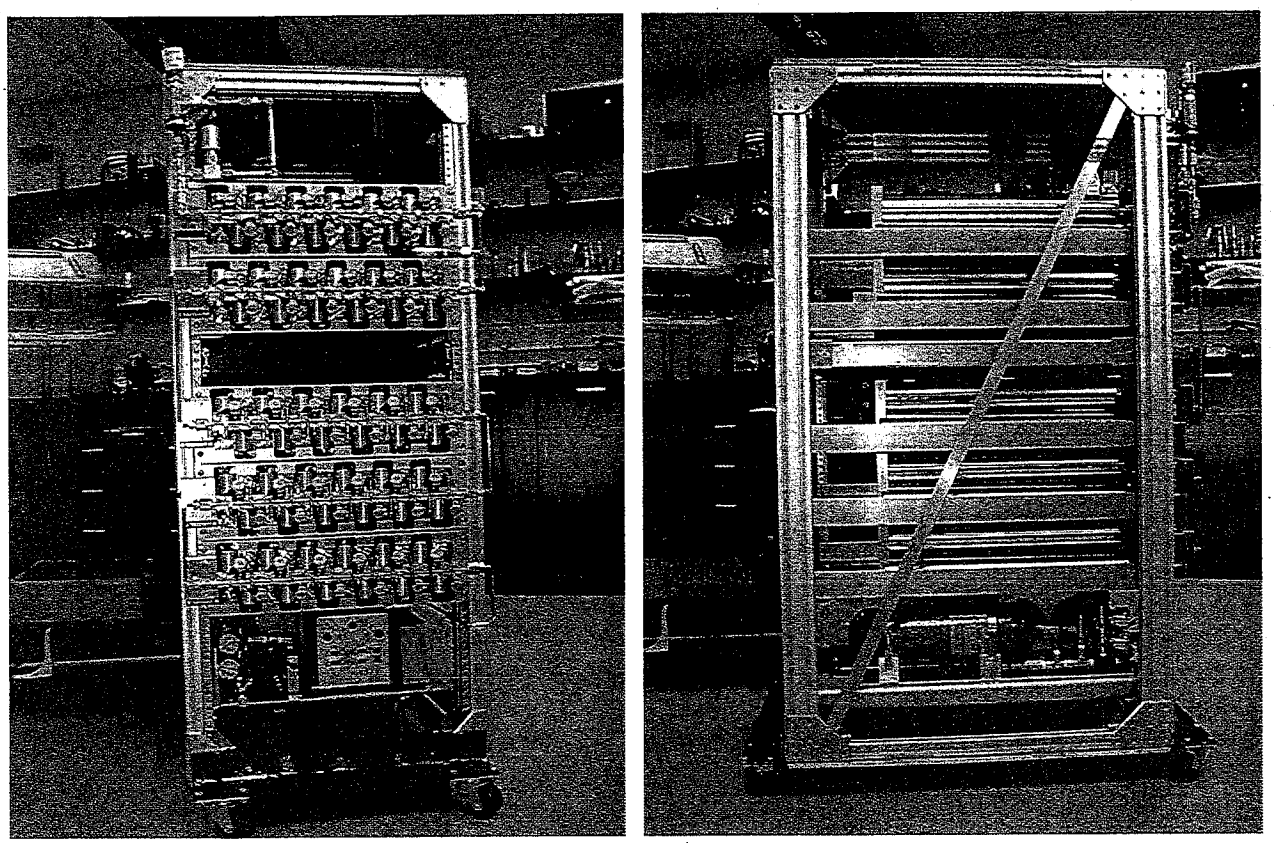

Figure 1. Automated whole air sampling rack to be used aboard the NOAA WP-3 aircraft during CalNex 2010. The rack holds 6 sets of twelve 1.6-L air sampling canisters (72 canisters in total).

Laboratory Analysis

All airborne and ground-based samples will be returned to our UC-Irvine laboratory and promptly analyzed by gas chromatography (GC) for more than 60 VOCs including methane (CH_4), carbon monoxide (CO), C_2-C_{10} NMHCs, C_1-C_2 halocarbons, C_1-C_5 alkyl nitrates, and selected sulfur compounds (Table 1). We are also capable of measuring other species such as oxygenated compounds (e.g. ethanol). Our group has extensive prior experience in airborne NOAA and NASA field missions and all gases will be reported at a high level of precision and accuracy in a timely fashion.

Our experiment procedures will build on those that have been successfully employed for numerous prior NASA field missions, most recently ARCTAS-California [*Yang et al.*, 2008, submitted], INTEX-A and B [*Blake et al.*, 2008], TRACE-P [*Blake et al.*, 2003b, 2003d; *Simpson et al.*, 2003a, 2003b], and PEM-Tropics B [*Blake et al.*, 2001, 2003c; *Colman et al.*, 2001; *Simpson et al.*, 2001]. These analytical procedures are outlined as follows.

Table 1. Selected compounds measured by the UC-Irvine group.

Compund	Formula	Lifetime	LOD (pptv)	Precision (%)	Accuracy (%)
Hydrocarbons					
Ethane	C_2H_6	2-3 mo	3	0.5	5
Ethene	C_2H_4	1-2 d	3	0.7	5
Ethyne	C_2H_2	12-17 d	3	0.5	5
Propane	C_3H_8	1-2 wk	3	0.7	5
Propene	C_3H_6	8-12 hr	3	16	5
Propyne	C_3H_4	2 d	3	2	5
n-Butane	C_4H_{10}	4-6 d	3	0.6	5
i-Butane	C_4H_{10}	5-7 d	3	1	5
1-Butene	C_4H_8	9 hr	3	2	5
cis-2-Butene	C_4H_8	5 hr	3	2	5
trans-2-Butene	C_4H_8	5 hr	3	2	5
1,3-Butadiene	C_4H_6	5 hr	3	2	5
n-Pentane	C_5H_{12}	5 d	3	2	5
i-Pentane	C_5H_{12}	5 d	3	2	5
Isoprene	C_5H_8	1-2 hr	3	2	5
2-Methylpentane	C_6H_{14}	2-3 d	3	2	5
3-Methylpentane	C_6H_{14}	2-3 d	3	2	5
Benzene	C_6H_6	9-13 d	3	2	5
Toluene	C_7H_8	2-3 d	3	3	5
m-Xylene	C_8H_{10}	1 d	3	5	5
o-Xylene	C_8H_{10}	1-2 d	3	5	5
p-Xylene	C_8H_{10}	1-2 d	3	5	5
Ethylbenzene	C_8H_{10}	2 d	3	5	5
m-Ethyltoluene	C_9H_{12}	17 hr	3	5	5
o-Ethyltoluene	C_9H_{12}	1 d	3	5	5
p-Ethyltoluene	C_9H_{12}	1 d	3	5	5
1,2,4-Trimethylbenzene	C_9H_{12}	10 hr	3	5	5
1,3,5-Trimethylbenzene	C_9H_{12}	5 hr	3	5	5
α-Pinene	$C_{10}H_{16}$	6 hr	3	5	5
β-Pinene	$C_{10}H_{16}$	4 hr	3	5	5
Alkyl Nitrates					
Methyl nitrate	CH_3ONO_2	1 mo	0.02	2	10
Ethyl nitrate	$C_2H_5ONO_2$	2-4 wk	0.02	1	10
1-Propyl nitrate	$C_3H_7ONO_2$	1-2 wk	0.02	1	10
2-Propyl nitrate	$C_3H_7ONO_2$	1-3 wk	0.02	2	10
2-Butyl nitrate	$C_4H_9ONO_2$	1-2 wk	0.02	1	10
2-Pentyl nitrate	$C_5H_{11}ONO_2$	4-5 d	0.02	2	10
3-Pentyl nitrate	$C_5H_{11}ONO_2$	4-5 d	0.02	2	10

Table 1, continued. Selected compounds measured by the UC-Irvine group.

Compound	Formula	Lifetime (pptv)	LOD (%)	Precision (%)	Accuracy
Halocarbons					
CFC-11	$CFCl_3$	45 yr	1	0.8	2
CFC-12	CF_2Cl_2	100 yr	10	0.7	2
CFC-113	CCl_2FCClF_2	85 yr	1	1.2	2
CFC-114	$CClF_2CClF_2$	300 yr	1	1.9	5
Methyl chloroform	CH_3CCl_3	4.9 yr	1	1.0	5
Carbon tetrachloride	CCl_4	35 yr	0.1	0.7	5
Halon-1211	$CBrClF_2$	11 yr	0.05	1.1	5
Halon-2402	$CBrF_2CBrF_2$	<20 yr	0.05	2.5	5
HCFC-22	CHF_2Cl	11.8 yr	1	2.0	5
HCF-134a	CH_2FCF_3	13.6 yr	1	5.2	10-20
HCFC-141b	CH_3CCl_2F	9.2 yr	1	4.2	10-20
HCFC-142b	CH_2CClF_2	18.5 yr	1	3.6	10-20
Methyl bromide	CH_3Br	9-10 mo	0.1	1.7	5
Methyl chloride	CH_3Cl	1.3 yr	5	1.5	5
Methyl iodide	CH_3I	4 d	0.01	1.1	10
Methylene bromide	CH_2Br_2	3-4 mo	0.05	1.6	10-20
Methylene chloride	CH_2Cl_2	3-5 mo	1	4.5	10
Chloroform	$CHCl_3$	3-5 mo	0.1	1.1	5
Trichloroethene	C_2HCl_3		0.05	1.5	5
Tetrachloroethene	C_2Cl_4	2-3 mo	0.05	1.2	10
1,2-Dichloroethane	C_2H_6	1-2 mo	0.05	5.0	20
Bromodichloromethane	$CHBrCl_2$	2-3 mo	0.01	2.0	10-20
Dibromochloromethane	$CHBr_2Cl$	2-3 mo	0.01	9.3	20
Bromochloromethane	CH_2BrCl	5 mo	0.01	7.4	20
Sulfur Compounds					
Carbonyl sulfide	OCS	16 yr	10	2	10
Dimethyl sulfide	CH_3SCH_3	1-2 d	10	2	10
Dimethyl disulfide	CH_3SSCH_3	1 hr	10	2	10
Carbon disulfide	CS_2	2-3 d	10	2	10

For each air sample a 1520 cm^3 sample aliquot (at ambient temperature and pressure) is introduced into the analytical system's manifold and then passed over glass beads contained in a loop and maintained at liquid nitrogen temperature. The flow is regulated by a Brooks Instrument mass flow controller (model 5850E), and is kept below 500 cm^3/min to ensure complete trapping of the relevant components. This procedure pre-concentrates the relatively less volatile components of the sample (such as halocarbons and hydrocarbons) while allowing more volatile components (such as N_2, O_2, and Ar) to be pumped away. These less volatile

compounds are next re-volatilized by immersing the loop containing the beads in hot water (80°C), and then flushed into a helium carrier flow (head pressure 48 psi). The sample flow is then split into six streams. Each stream is chromatographically separated on an individual column and sensed by a single detector. Three gas chromatographs (HP 6890) form the core of the analytical system. We use two flame ionization detectors (FID, sensitive to hydrocarbons), two electron capture detectors (ECD, sensitive to halocarbons and alkyl nitrates), and one quadrupole mass spectrometer detector (MSD, for unambiguous compound identification and selected ion monitoring). The GC/column/detector details are given in Table 2.

Table 2. Details of the analytical configuration to be used by UC-Irvine during CalNex 2010.

GC	Column	Detector	Percent flow received
GC-1	DB-5[a]/Restek-1701[b]	ECD	9
GC-1	DB-5ms[c]	MSD	12
GC-2	DB-1[d]	FID	16
GC-3	Restek-1701[e]	ECD	9
GC-3	PLOT[f]/DB-1[g]	FID	64

[a] DB-5 column (30 m, I.D. 0.25 mm, film 1 mm)
[b] Restek-1701 column (5 m, I.D. 0.25 mm, film 0.5 mm)
[c] DB-5ms column (60 m, I.D. 0.25 mm, film 0.5 mm)
[d] DB-1 column (60 m, I.D. 0.32 mm, film 1 mm)
[e] Restek-1701 (60 m, I.D. 0.25 mm, film 0.50 mm)
[f] GS-Alumina PLOT column (30 m, I.D. 0.53 mm)
[g] DB-1 column (5 m, I.D. 0.53 mm, film 1 mm)

The J&W Scientific DB-1 is a cross-linked surface bonded dimethyl-polysiloxane column and is the most non-polar siloxane stationary phase available. It separates gases based roughly on their boiling point. The J&W DB-5 is similar to the DB-1 but with 5% of the methyl side groups replaced with phenyl groups. It is slightly more polar than the DB-1. The DB-5ms is simply a lower bleed version of the DB-5 column. The GS-Alumina Porous Layer Open Tubular (PLOT) column is useful for complete resolution of C_2-C_5 hydrocarbon mixtures. Its separation properties are based on a gas-solid interaction (rather than gas-liquid). The Restek-1701 is a cross-linked surface bonded 14% cyanopropylphenyl-/86% dimethyl-polysiloxane column whose "unique" polarity helps in the separation of halogenated compounds. The signal from each detector is output to a Spectra Physics 4400 integrator, which produces hardcopies of the analog response, and to a personal computer where the signal is recorded digitally using Labnet software (Spectra Physics, San Jose, CA). Each resulting chromatogram is manually modified, and each peak shape individually checked. This type of quality control is very important for datasets of a large size, such as we anticipate collecting during CalNex 2010, because a slight change in retention time or peak shape can create problems for automated quantification.

We generate our own zero-air and nitrogen for use in our FIDs and ECDs. House air is passed through a CUNO Inc. model AP101T aqua pure water filter filled with glass wool, then through a Whatman 64-02 air dryer equipped with a 100-12 BX prefilter. This removes oil, water, and particulates from the air stream, which is then split and directed into a Domnick Hunter nitrox-nitrogen generator (NG7-0) and a Praxair zero-air generator (model Airlab WHA 76803). The output from these devices are split further and directed into gas regulators for head pressure regulation. Before entering our analytical system, all gases are passed through homemade graphite/molecular sieve traps to remove any remaining contaminants. These traps are preconditioned (and regenerated) by flowing hydrogen gas through them at a temperature of 5°C for at least 5 hours. Both of our FIDs operate at a detector temperature of 250°C with a zero-air flow of 450 mL/min, an H_2(g) flow of 40 mL/min, and a detector makeup gas flow of 20 mL/min N_2(g). Our ECDs operate at a detector temperature of 250°C with a detector makeup flow of 50 mL/min N_2(g).

The relative flow passing through an individual column depends primarily on its inner diameter. We split the flow among the channels in such a way as to facilitate detection of a variety of halocarbon and hydrocarbon species. The majority of the flow is directed to the PLOT column, due in part to the lower per-molecule sensitivity of the FID and the low ambient levels of Page

many nonmethane hydrocarbons that are encountered in non-urban environments, as we expect to encounter during portions of the CalNex 2010 project. The split ratios are found to be highly reproducible as long as the specific humidity of the injected air is above 2 g-H_2O/kg-air. For this reason (as well as to increase the stability of certain compounds in the canisters) 10 Torr of water is added to each preconditioned, evacuated canister before it is sent into the field.

Calibration and Measurement Intercomparisons

Calibration is an ongoing process, whereby new standards are referenced to older certified standards, with appropriate checks for stability and with regular inter-laboratory comparisons. Multiple standards are employed, including working standards that are analyzed every four samples and absolute standards that are analyzed twice daily. Our laboratory technicians regularly collect and calibrate pressurized cylinders of air from different environments for use as working standards. During CalNex 2010 we will employ working standards collected on the coast north of Cayucos, California; at the California Sierra Nevada Mountains at 12,000 feet altitude; and near Escondido, California.

Our primary reference standard for halocarbons was previously calibrated from static dilutions of standards prepared in this laboratory. Its absolute accuracy is tied to a manometer measurement and how accurately the appropriate volume ratios for the dilution line used are known. For hydrocarbons, we use a propane standard purchased from the National Bureau of Standards (SRM 1660A) to calculate a Per-Carbon-Response-Factor (PCRF) for our FIDs. This is compared to PCRFs calculated from more readily available commercial standards to check the absolute accuracy of the commercial standard, as well as the appropriateness of using the same PCRF for different compounds. From analysis of the commercial standard we assign a different PCRF for each alkane, from ethane to octane. This PCRF is then used for any compound with an equivalent number of carbons. For example, the PCRF determined for butane is employed during quantification of the butenes.

We estimate our typical absolute accuracy as 2-10%, increasing as we approach our detection limits [*Colman et al.*, 2001]. We impose a conservative limit of detection (LOD) of 3 pptv on the NMHCs. The halocarbon LOD varies by compound, from 0.01 pptv for chlorobrominated species (e.g. $CHBrCl_2$, $CHBr_2Cl$, CH_2BrCl) to 10 pptv for CFC-12 (Table 1).

Although we go to great lengths to carefully condition and re-condition our stainless steel sampling canisters, they are known to be subject to slight alkene growth during whole air storage, to a maximum of about 0.1-0.2 pptv per day. During prior airborne field missions the samples have been analyzed within 10 days of collection, and often sooner, which limited the size of any artifact to 2 pptv or less. Because of the canister turnaround requirements during CalNex 2010, and because many flights will deploy from bases close to our laboratory in Southern California, we anticipate analyzing each sample within 2-5 days of its collection.

We have been involved in numerous NOAA, NASA and NSF airborne and ground-based projects during which more than 30,000 whole air samples have been collected and assayed for a wide range of hydrocarbons and halocarbons. Once the samples are assayed, the stored chromatograms are individually inspected and the reports from those chromatograms are then summarized in spreadsheet format and checked for inconsistencies. Once the quality control is complete the data are ready for archival. We expect to archive CalNex 2010 data within 6 months of completion of the field program.

1.4.2 Tasks to be Conducted

Our specific tasks to be conducted for the CalNex 2010 project are as follows:

1. Fall 2009:	**Fabricate canisters.** If funding allows, fabricate an additional 6 sets of 12 canisters for use during CalNex.
2. March 2010:	**Coordinate integration.** Collaborate with Elliot Atlas (University of Miami) and NOAA personnel with respect to integration issues (e.g. aircraft requirements, system configuration on the WP-3, etc.) and logistical issues (e.g. deployment of UC-Irvine canisters to the field for airborne sampling).
3. April 2010:	**Prepare canisters.** Condition and evacuate sampling canisters in preparation for field use.
4. May 2010:	**Conduct integration.** Communicate with Elliot Atlas regarding transport and integration of whole air sampling equipment on the WP-3.
5. May 2010:	**Prepare laboratory.** UC-Irvine team is ready for the field mission to begin. Primary and working calibration standards are ready for use and the analytical system is operational. Logistics are in place for the efficient shipment of empty sampling canisters to the field, and for the return of filled canisters.
6. June-July 2010:	**Collect airborne and ground-based samples.** Our colleague Elliot Atlas coordinates the airborne whole air sampling. Our group performs ground-level whole air sampling in Los Angeles, San Francisco, and the San Joaquin valley, in coordination with the CalNex flights.
7. June-August 2010	**Analyze airborne and ground-based samples.** Analytical system is running. Filled canisters are promptly returned to UC-Irvine and analyzed for more than 50 volatile organic compounds (VOCs) using gas chromatography (GC) with flame ionization detection (FID, sensitive to hydrocarbons), electron capture detection (ECD, sensitive to halocarbons and organic nitrates), and mass spectrometer detection (MSD, for unambiguous compound identification). The analyzed canisters are then re-conditioned and evacuated in preparation for prompt return to the aircraft.
8. August 2010:	**Coordinate disintegration.** In collaboration with Elliot Atlas, the in-flight whole air sampling system is disintegrated and returned to UC-Irvine.
9. Sep.2010-Apr.2011:	**Perform data quality control.** Chromatograms are individually modified and data are quality controlled and submitted to the NOAA archive.
10.Jan.-Apr. 2011:	**Disseminate results.** UC-Irvine personnel interpret the data, participate in data workshops in conjunction with other CalNex 2010 participants, and present the results at scientific meetings and conferences. Final reports are written for CARB.

1.4.3 Data Management Plan

Data to be collected. During CalNex 2010 we will collect more than 1000 whole air samples, which will each be analyzed for more than 60 individual volatile organic compounds. The

classes of compounds to be measured include CH_4, CO, C_2-C_{10} nonmethane hydrocarbons, C_1-C_2 hydrocarbons, C_1-C_4 alkyl nitrates, and C_1-C_2 sulfur species.

Sample size required. *Airborne.* We will collect 72 1.4-L whole air samples per flight of the NOAA WP-3 aircraft. As discussed in Section 1.4.1, the sampling interval will depend on the duration of the flight and the interesting science that is encountered on the flight. For example, a sample could be collected on average every 5 minutes during a 6-hour science flight. Elliot Atlas, who will be responsible for management of the aircraft sampling, has extensive experience regarding whole air sampling strategies during airborne missions, with particular experience aboard the NOAA WP-3. Our previous flight experience has shown that this sampling frequency is well-suited to accomplish the data analysis and interpretation outlined in Sections 1.1 and 1.3.
Ground-based. We will collect 100-200 samples each in San Francisco and Los Angeles, in a grid pattern. These data will be used to quantify ambient trace gas mixing ratios in each city and identify local sources. We will also collect 100-200 air samples throughout the San Joaquin valley, to characterize VOC concentrations and sources in non-urban areas of California. Our previous work in the San Joaquin Valley has shown that this sample size is sufficient to assess key trace gas sources in the region. For example, we have shown that oxygenates such as ethanol are elevated within the valley, by contrast to values in Sacramento (Figure 2). These oxygenate enhancements have been attributed to emissions from silage on dairy farms, and we have successfully used these data to perform bottom-up emission estimates of oxygenates from the valley [*Yang et al.*, 2008, submitted].

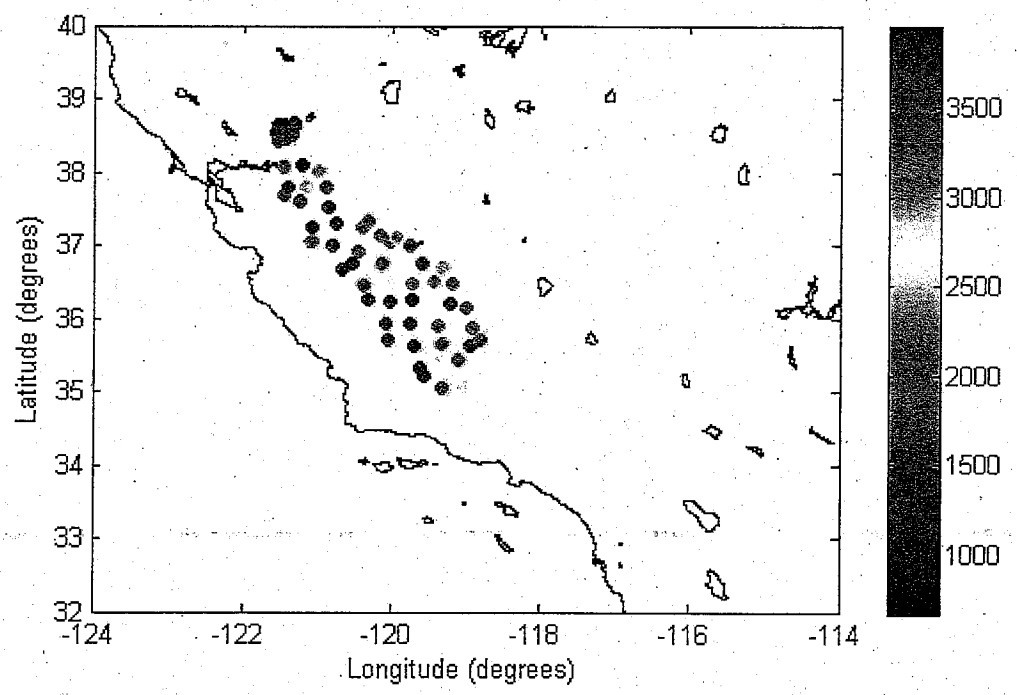

Figure 2. Ethanol profile of the San Joaquin Valley based on a ground-based grid study on March 6, 2008 [*Yang et al.*, 2008, submitted]. Sacramento samples are shown in the top left.

Methods of data handling, reduction, and analyses. For each whole air sample that is analyzed, the signals from the ECDs and FIDs are output to a personal computer where they are digitally recorded using Chromeleon Software. The output signal from the MSD is digitally recorded using Chemstation software. Each chromatogram is then manually modified and each

peak shape is individually inspected. This painstaking hands-on data handling ensures that our data are of the highest quality. The modified data are then assembled into a spreadsheet format and are carefully detrended using our calibration data.

Data format. Data will be archived in spreadsheet format. For each whole air sample, the following data will be recorded in the spreadsheet: canister number; sampling location (including latitude and longitude); sampling time and date (including canister opening and closing times); sampling altitude; local temperature; local wind direction; local wind speed; mixing ratio of each VOC.

Approach to addressing data quality assurance. Ensuring high quality data is a top priority in our research group. We believe in a rigorous approach that combines years of technical expertise with painstaking attention to detail, including the labor-intensive individual inspection of each peak on each gas chromatograph. Once mixing ratios have been assembled into spreadsheet format and detrended for any drift, our data quality assurance repeats the individual inspection of each data point, whereby each trace gas mixing ratio is inspected and outliers are removed.

1.4.4 Equipment Testing Procedures

The UC-Irvine analytical system has been in operation for more than 20 years. Our equipment is regularly tested, upgraded and maintained to the highest standards. We have cross-checked our calibration scheme (Section 1.4.1) against absolute standards from other groups for both hydrocarbons and halocarbons, for example with our colleague Elliot Atlas (University of Miami) who is a collaborator with us during CalNex 2010. Additionally, we have participated in the Non-Methane Hydrocarbon Intercomparison Experiment (NOMHICE). The results of this experiment demonstrate that our analytical procedures consistently yield accurate identification of a wide range of unknown hydrocarbons and produce excellent quantitative results [e.g. *Apel et al.*, 2003]. We are currently participating in the Global Atmosphere Watch (GAW) intercomparison program. Such intercomparisons have demonstrated the effectiveness of our equipment testing, maintenance and upgrading procedures.

1.4.5 Laboratory Facilities

Our UC-Irvine laboratory is a world-class facility that is housed in the basement of the Chemistry Building (Rowland Hall) at UC-Irvine. The laboratory has been located here for many years and its operation runs smoothly and efficiently. The laboratory is staffed by two full-time technicians (Brent Love and Gloria Liu), one part-time technician (Rafe Day), and a senior research assistant (Simone Meinardi), with additional help from graduate students and postdoctoral fellows. The instrumentation is described in Section 1.4.1. To recap, three gas chromatographs (HP 6890) form the core of the analytical system. We use two flame ionization detectors (FID, sensitive to hydrocarbons), two electron capture detectors (ECD, sensitive to halocarbons and alkyl nitrates), and one quadrupole mass spectrometer detector (MSD, for unambiguous compound identification and selected ion monitoring).

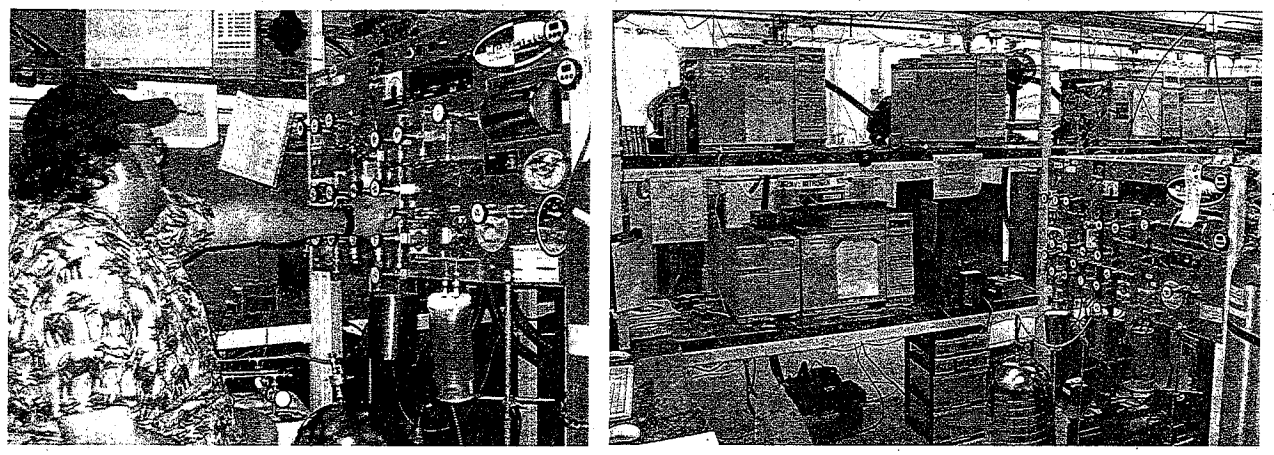

Figure 3. Senior technician Brent Love operating the UC-Irvine analytical system (left). Three gas chromatographs that form the core of the analytical system (right).

1.4.6 References

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2. PROJECT SCHEDULE

The timeline for the work schedule outlined in Section 1.4.2 is as follows, assuming that the CalNex flights will occur in June and July 2010.

Task 1:	Fabricate 72 additional air sampling canisters	May-Dec., 2009
Task 2:	Coordinate aircraft integration (Elliot Atlas)	March, 2010
Task 3:	Prepare air sampling canisters for field use	April, 2010
Task 4:	Conduct aircraft integration (Elliot Atlas)	May, 2010
Task 5:	Prepare laboratory	May, 2010
Task 6:	Collect airborne and ground-based samples	June-July, 2010
Task 7:	Analyze airborne and ground-based samples	June-August, 2010
Task 8:	Coordinate disintegration (Elliot Atlas)	August, 2010
Task 9:	Work up data	Sep.2010-Apr.2011
Task 10:	Disseminate results	Jan-April, 2011

The beginning and end dates of Tasks 2-10 are shown in Table 3. The first task (fabrication of 72 additional air sampling canisters) will occur in the fall of 2009 and is not included in Table 3. The exact dates of each task will depend on the specific aircraft deployment dates.

Table 3. Schedule of tasks to be completed as part of this proposal's work plan. Task 1 (not listed) will be completed in Fall 2009. Month 1 is defined as May 2009, and Month 24 is April 2011.

TASK	MONTH	2	4	6	8	10	12	14	16	18	20	22	24
1		■	■	■									
2					■								
3						■							
4							■						
5							■						
6								■	■				
7								■	■				
8									■				
9										■	■	■	■
10											■	■	■
		m	p		p	m	p		p	d m	p		F

p = Quarterly progress report
d = Deliver draft final report (to be submitted 6 months prior to contract expiration)
F = Deliver final report
m = Meeting with ARB staff

3. PROJECT MANAGEMENT PLAN

3.1 PI and technical personnel

Table 4. Key personnel from UC-Irvine who will conduct the proposed research during CalNex 2010.

Name	Position	Role during CalNex 2010	Work Commitment (Months)
Donald Blake	Professor	PI, Project Manager	1.5 months
F. Sherwood Rowland	Professor	Consultant	0.75 months
Brent Love	Senior Technician	Technician	5.5 months
Gloria Liu	Technician	Technician	5.5 months
Isobel Simpson	Associate Specialist	Researcher	3.5 months
Simone Meinardi	Assistant Researcher	Researcher	5.5 months
Nicola Blake	Assistant Researcher	Researcher	3.5 months
Melissa Yang	Graduate Student	Researcher	7.4 months
Matt Carlson	Graduate Student	Researcher	3.7 months
Brandon Umber	Graduate Student	Researcher	3.7 months
Barbara Chisholm	Assistant Analyst	Logistical support	3 months

3.2 Assigned responsibilities

Professor **Donald R. Blake** (PI and Project Manager) will direct the project. He will be responsible for coordinating the field sampling logistics, analysis of samples during the mission, and quality control of the resulting data. He will also coordinate laboratory logistics during the mission, including canister preparation and shipment, sample analysis, and data quality control and archiving. Once the data are archived he will oversee the data interpretation and journal article preparation. Professor Blake will also liaise with colleagues from other groups during the CalNex mission.

Professor **F. Sherwood Rowland** will advise on sampling strategy and be involved in the interpretation of initial results as they become available during the field deployment. Assistant researcher **Simone Meinardi** will participate in the research development process and will coordinate the calibration for each trace gas. He and graduate student **Melissa Yang** and Assistant researcher **Nicola Blake** will conduct the ground-level field sampling and the subsequent data analysis and preparation of manuscripts. Graduate students **Matt Carlson** and **Brandon Umber** will assist in sample analysis in the UCI laboratory. Associate specialist **Isobel Simpson** will assist in data interpretation and manuscript preparation. Technicians **Brent Love** and **Gloria Liu** will prepare each canister for field deployment. They will analyze each sample, modify the resulting chromatograms, and assemble the data into a usable format. Assistant analyst **Barbara Chisholm** will be responsible for logistical management throughout the CalNex field project. She will also be in charge of shipping canisters and maintaining communication between the field scientists and the UCI laboratory.

3.3 Project management and coordination

Our research group has been involved in dozens of NASA and NSF funded airborne and ground based atmospheric studies. We will manage this CalNex study in a similar way that we have managed previous studies. Meetings will be scheduled as needed as will communication with those in the field. CARB will be communicated with on a timely basis and suggestions by CARB scientists will be discussed and acted upon in a timely fashion. During the ARCTAS airborne project our group interacted with Jim Pederson and Tony VanCuren in a productive and enjoyable manner and we anticipate CalNex to move forward in a similar fashion.

3.4 Curriculum vitae

3.4.1 Donald R. Blake, Principal Investigator

NAME	POSITION TITLE
Donald Ray Blake	Professor of Chemistry and Earth System Science

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
University of California, Los Angeles	B.S.	1978	Chemistry
University of California, Irvine	M.S.	1980	Chemistry
University of California, Irvine	Ph.D.	1984	Chemistry

A. Positions and Selected Honors

U.S. Navy	1971-1974
Research Assistant, University of California Irvine	1978-1984
Postdoctoral Research Associate, University of California Irvine	1984-1985
Research Specialist, University of California Irvine	1985-1991
Associate Research Chemist, University of California Irvine	1991-1994
Research Chemist, University of California Irvine	1994-1998
Professor of Chemistry, University of California Irvine	1998-present
Chair of the Chemistry Department, University of California Irvine	2007-present
AAAS Fellow	2008
NASA Group Achievement Award	2008, 2006, 2000, 1998, 1993
Outstanding Professor, Alpha Phi Society	2005, 2002, 2000
ACS Chuck Bennett Service through Chemistry	2004
Excellence in Undergraduate Research Mentoring	2001

B. Selected Peer-reviewed Publications (from a total of 412)

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C. Ongoing Atmospheric Research Support (Partial List)

National Aeronautical and Space Administration (NASA) Continued monitoring of trace gases at remote locations (71°N to 47°S) This study obtains remote air samples and determines their composition. Role: PI 5%	06/01/06 – 05/31/10 $891,943
California Air Resources Board (CARB) Sampling at Mount Wilson and Walnut Grove This study identifies gases emitted in remote California and compares them to urban areas.	06/15/08 – 06/14/10 $424,028
National Aeronautical and Space Administration (NASA) Whole Air Sampling (WAS) during TC[4] This study collects and analyzes airborne air samples over the Costa Rican region. Role: PI 5%	05/15/07 – 05/14/09 $346,175

National Aeronautical and Space Administration (NASA) 6/1/08 – 5/31/11
Whole Air Sampling (WAS) during ARCTAS $400,000
This study collects and analyzes air samples during an airborne mission over North America.
Role: PI 5%

4. RELATED RESEARCH

Our laboratory specializes in the quantification of more than 100 trace gases including CH_4, CO, C_2-C_{10} non-methane hydrocarbons, C_1-C_2 halocarbons, C_1-C_5 alkyl nitrates, and selected sulfur compounds. We currently apply this expertise to two research areas: (1) *atmospheric chemistry* and (2) *analysis of trace gases in exhaled breath*. Our atmospheric chemistry research relates to this proposal and is discussed below.

For the past 30 years, our group has studied the composition and chemistry of the earth's atmosphere. Our research uses a variety of ground-level and airborne research platforms to investigate remote, rural and urban atmospheric environments. Currently funded projects are summarized in Table 5.

Table 5. Research that is currently underway by the applicant in areas related to the proposal, together with the source and amount of research funds.

National Aeronautic and Space Administration (NASA) 11/01/08 – 10/31/09
Whole Air Sampling (WAS) during ARCTAS 2008 $227,426
This airborne study obtained Arctic air samples and is determining their composition.

California Air Resources Board (CARB) 06/15/08 – 06/14/10
Sampling at Mount Wilson and Walnut Grove $424,028
This study identifies gases emitted in remote California and compares them to urban areas.

California Air Resources Board (CARB) 05/01/08 – 10/31/09
Whole Air Sampling (WAS) during ARCTAS-California 2008 $400,000
This airborne study obtained Arctic air samples and is determining their composition.

National Aeronautical and Space Administration (NASA) 05/15/07 – 05/14/09
Whole Air Sampling (WAS) during TC^4 2007 $346,175
This airborne study collected and analyzed air samples from Costa Rica.

National Aeronautical and Space Administration (NASA) 06/01/06 – 05/31/10
Continued global monitoring of trace gases (71°N to 47°S) $891,943
This study obtains remote air samples and determines their composition.

Private funding from the Comer Foundation 02/01/06 – 01/31/09
Identification and quantification of climate change gases $220,000
This study investigates gases that could affect abrupt climate change.

National Aeronautical and Space Administration (NASA) 11/15/05 – 11/14/08
Whole Air Sampling (WAS) during INTEX-B 2006 $800,000
This airborne study analyzed whole air samples obtained over North America.

California Air Resources Board (CARB) 6/1/05-12/31/08
Emission reductions in the San Joaquin Valley $111,750
This study evaluates and compares mitigation practices in the San Joaquin Valley.

Airborne Missions

Our group has extensive experience in airborne field campaigns. Since 1988 our research group has been involved in more than a dozen NASA and NSF sponsored airborne projects (http//www.gte.larc.nasa.gov; Figure 4). During these missions our group collects up to 168 whole air samples per flight aboard the NASA DC-8 research aircraft, and up to 144 samples per flight aboard the NASA P-3B. The objective of the missions is to better understand human impacts on the composition and chemistry of the global troposphere.

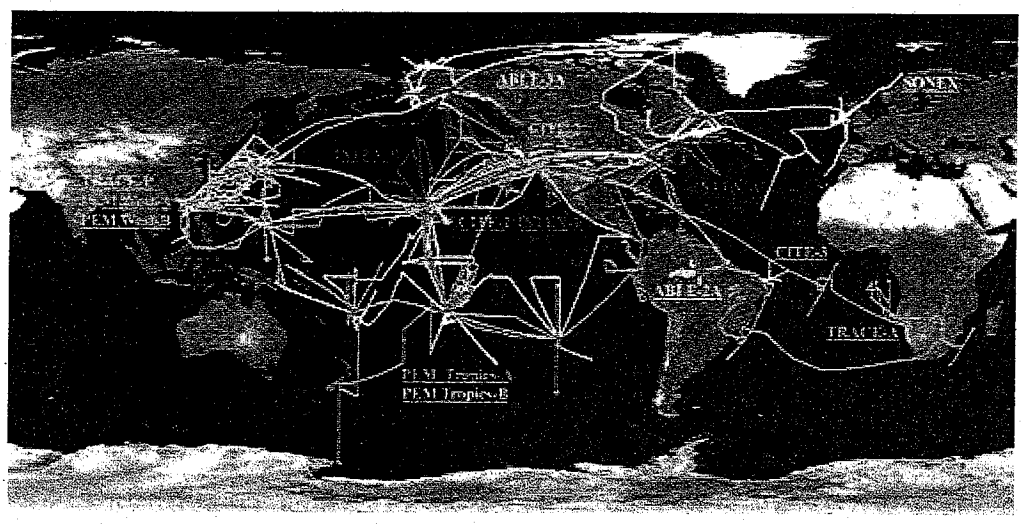

Figure 4. NASA airborne tropospheric chemistry field campaigns, 1983-2006. Our group has participated in all but one of these missions. http://www-gte.larc.nasa.gov/trop_map.htm.

ARCTAS mission, 2008. Most recently our group participated in the summer 2008 Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS) field mission, which seeks to better understand the Arctic troposphere and processes that impact climate and air quality. Based on the many hundreds of air samples that our group collected during the spring and summer aircraft deployments (based in Fairbanks, Alaska and Cold Lake, Alberta, respectively) we will be furthering our understanding of (1) long-range transport of pollution to the Arctic including Arctic haze, tropospheric O_3 and persistent pollutants; (2) boreal forest fires and their implications for atmospheric composition and climate; and (3) chemical processes with focus on O_3 and aerosols, including particular the chemistry of halogen and hydrogen oxide radicals, and stratosphere-troposphere exchange.

TC^4 mission, 2007. The 2007 Tropical Composition, Cloud and Climate Coupling (TC^4) mission investigated convective processes in the eastern tropical Pacific in July 2007, based in Costa Rica. High altitude aircraft collected tropopause data while medium altitude aircraft provided profiles and structure measurements of the tropical upper troposphere and lower

stratosphere. Our group's measurements of established tracers of tropical convection (CH_3I, DMS, and CH_3ONO_2, each with different atmospheric lifetimes), together with our comprehensive array of other tracers, was critical for interpreting the relationship between observations of upper tropospheric humidity and convection. Our tracers were also used to determine the history of the various air parcels sampled from different regions of tropical cloud systems, and they provided vital clues to the origin of layers of high relative humidity and cirrus layers that are often observed in the upper troposphere. In addition to being required for the correct interpretation of tropical convection, our data were used to study chemical, dynamical and physical processes occurring in the tropical upper troposphere and in the layer surrounding the tropical tropopause.

INTEX NA field mission. In summer 2004 and spring 2006 we participated in the first and second phases of the Intercontinental Chemical Transport Experiment-NA (INTEX-NA), which sought to understand the transport and transformation of gases and aerosols on transcontinental/intercontinental scales and assess their impact on air quality and climate. During the first phase of INTEX (INTEX-A) we flew over the eastern USA and Canada, and during INTEX-B we collected both airborne and ground-based samples in order to characterize pollution outflow from Mexico City and from Asia. Highlights from this work include a large-scale assessment of carbonyl sulfide (COS) levels over North America, including the observation that that summertime OCS mixing ratios at low altitude were dominated by surface drawdown and were highly correlated with CO_2, and that modeled fluxes underestimate the OCS plant sink by more than 200% [*Blake et al.*, 2008; *Campbell et al.*, 2008].

Other previous missions. We have also participated in the following missions within the past dozen years: TRACE-P (2001); TOPSE (2000); BIBLE-B (2000); PEM-Tropics B (1999); SONEX (1997); PEM-Tropics A (1996). Previous to this we participated in the ABLE, ACE, AASE, PEM-WEST, and CITE missions.

Ground-based missions

Our group has made seminal contributions to the assessment of trace gas levels at local, regional and global scales, in both urban and remote environments.

Global trace gas monitoring

Established in 1977, the UC-Irvine global monitoring network is the world's longest continuous record of directly measured trace gases [*Blake and Rowland*, 1986, 1988]. In order to determine "background" concentrations of selected trace gases, we have been collecting ~80 air samples at ~45 remote surface locations in the Pacific basin (Alaska to New Zealand) every three months since 1978 (Figure 5). More than 100 hydrocarbons and halocarbons—such as methane (CH_4), ethane (C_2H_6), chlorofluorocarbons (CFCs) and tetrachloroethene (C_2Cl_4)—are routinely present in the remote air samples [*Wang et al.*, 1995; *Gupta et al.*, 1998; *Simpson et al.*, 2002, 2004]. Our light hydrocarbon data set is unique in that is continuous since the mid-1980s. Our ethane data in particular has helped us understand the changes in methane's growth rate during the past two decades [*Simpson et al.*, 2006]. Specifically, because CH_4 and ethane fluctuations have tracked each other since 1990, the cause of these variations must include a source common to both CH_4 and ethane (we have ruled out their common sink, OH, as the cause of the fluctuations). The timing of the peaks matches major global biomass burning activity in Indonesia in 1997 and in boreal regions in 1998 and 2002-2003. Further, the CH_4

anomalies also track El Niño Southern Oscillation (ENSO) activity, which is consistent with additional hydrocarbon release from large-scale biomass burning triggered by drought conditions during El Niño years.

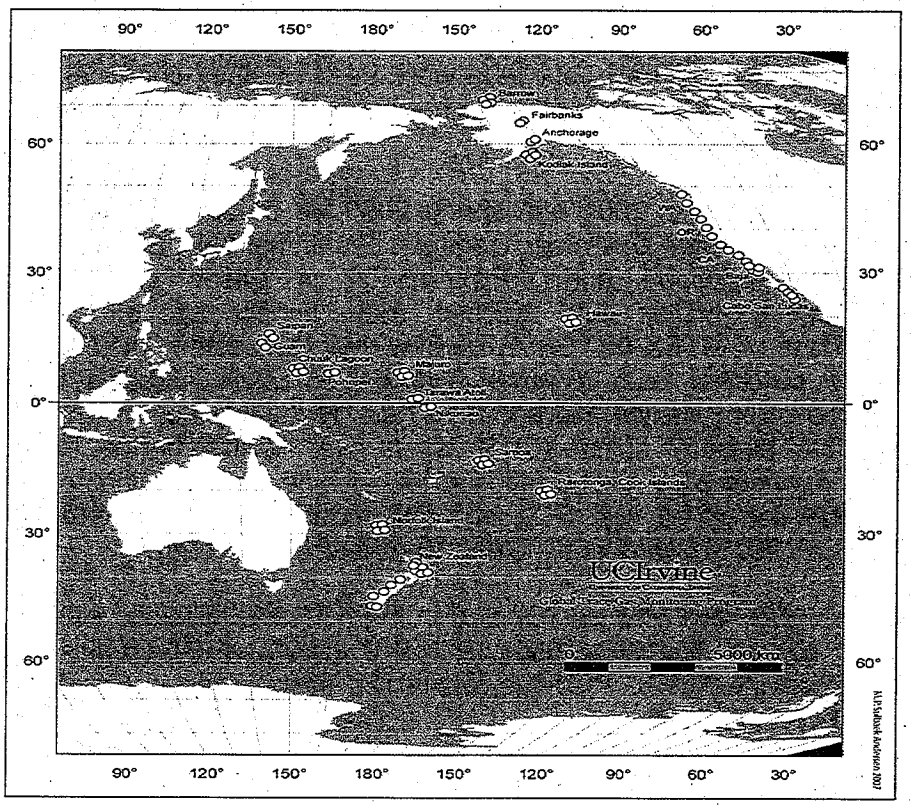

Figure 5. The UC-Irvine global trace gas monitoring network. Our group has collected ~80 air samples at about 45 remote surface locations in the Pacific basin (Alaska to New Zealand) every three months since 1978.

City studies

Our group discovered the impact of liquefied petroleum gas (LPG) leakage on the air quality in Mexico City and other cities [*Blake and Rowland*, 1995], and we pioneered the urban grid sampling technique during a 2001 study of Santiago, Chile [*Chen et al.*, 1999; 2001]. We have performed air quality analyses in more than 50 cities worldwide, including Karachi, Hong Kong, Beijing and Shanghai [*Barletta et al.*, 2002, 2005, 2008]. Our current work includes determining greenhouse gas emissions from the Los Angeles basin.

Regional studies

In addition to ground-based city studies, our group has made seminal contributions to the understanding of trace gas emissions on a regional scale. For example our group discovered extensive regional atmospheric hydrocarbon pollution in the southwestern United States resulting from the oil and natural gas industry [*Katzenstein et al.*, 2003]. Most recently our group

performed a grid study of the San Joaquin valley on March 6, 2008, in which we discovered that oxygenates (ethanol, methanol, acetone and acetaldehyde) were significantly enhanced compared to background concentrations [*Yang et al.*, 2008, submitted]. We plan to build upon our findings from the San Joaquin study during the work planned under this proposal.

5. PUBLICATIONS LISTS

PI Donald Blake is co-author on 412 peer-reviewed journal articles. Together these articles have been cited many thousands of times and Dr. Blake is an ISI Highly Cited Researcher. For example, the seminal article *Continuing worldwide increase in tropospheric methane, 1978 to 1987* [*Blake and Rowland*, 1998] has been cited 290 times (ISI Web of Knowledge), and the 1995 article *Urban leakage of liquefied petroleum gas and its impact on Mexico City air quality* [*Blake and Rowland*, 1995], in which we pioneered the use of grid sampling for city studies, has been cited 109 times. The following lists shows all publications from the Blake group since 2001 (indicated by an asterisk), together with selected publications by non-group members since 2002, as well as other selected group publications.

2008

* Baker, A. K., A. J. Beyersdorf, L. A. Doezema, A. Katzenstein, S. Meinardi, I. J. Simpson, **D. R. Blake**, F. S. Rowland, Measurements of nonmethane hydrocarbons in 28 United States cities, Atmos. Environ. 42 (1), 170-182, Jan. 2008.

* Barletta, B., S. Meinardi, I. J. Simpson, S. C. Zou, F. S. Rowland, **D. R. Blake**, Ambient mixing ratios of nonmethane hydrocarbons (NMHCs) in two major urban centers of the Pearl River Delta (PRD) region: Guangzhou and Dongguan, Atmos. Environ., 42 (18), 4393-4408, Jun. 2008.

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Campbell, J. E., G. R. Carmichael, T. Chai, M. Mena-Carrasco, Y. Tang, **D. R. Blake**, N. J. Blake, S. A. Vay, G. J. Collatz, I. Baker, J. A. Berry, S. A. Montzka, C. Sweeney, J. L. Schnoor, C. O. Stanier, Photosynthetic control of atmospheric carbonyl sulfide during the growing season, Science, 322 (5904), 1085-1088, 2008.

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EXHIBIT B

BUDGET DETAIL AND PAYMENT PROVISIONS

1. Invoicing

A. For services satisfactorily rendered in accordance with this agreement and upon receipt and approval of the invoices which properly detail all charges the Air Resources Board agrees to compensate the Regents of the University of California, Irvine for actual expenditures incurred in accordance with the rates specified in Exhibit B, Attachment 1.

B. Invoices shall include the Agreement Number and shall be submitted in triplicate not more frequently than quarterly in arrears to Ms. Emma Plasencia at the following address:

Air Resources Board
Research Division
P.O. Box 2815
Sacramento, CA 95812

C. Budget Flexibility: Subject to the prior review and approval of the contract manager, line item shifts of up to $25,000 or ten percent of the annual contract total, whichever is less, may be made up to a cumulative maximum of $25,000 or 10%, whichever is less, for all line item shifts over the life of the contract. There must be a substantial business justification for any shifts made. Fund shifts which increase Indirect, Overhead or General Expense line items are prohibited. Line item shifts may be proposed/requested by either the State or the University in writing and must not increase or decrease the total contract amount allocated. Any line item shifts must be approved in writing by the Division Chief of the Research Division, or his or her designee, and must be sent to the Contracts Section within 10 days of approval for inclusion in the contract folder. If the contract is formally amended, any line item shifts agreed to by the parties must be included in the amendment.

2. Budget Contingency Clause

A. It is mutually agreed that if the Budget Act of the current year and/or any subsequent years covered under this Agreement does not appropriate sufficient funds for the program, this Agreement shall be of no further force and effect. In this event, the State shall have no liability to pay any funds whatsoever to Contractor or to furnish any other considerations under this Agreement and Contractor shall not be obligated to perform any provisions of this Agreement.

EXHIBIT B

B. If funding for any fiscal year is reduced or deleted by the Budget Act for purposes of this program, the State shall have the option to either cancel this Agreement with no liability occurring to the State, or offer an agreement amendment to Contractor to reflect the reduced amount.

3. Payment

A. Costs for this Agreement shall be computed in accordance with State Administrative Manual Sections 8752 and 8752.1.

B. Nothing herein contained shall preclude advance payments pursuant to Article 1, Chapter 3, Part 1, Division 3, Title 2 of the Government Code of the State of California.

C. ARB shall withhold payment equal to ten percent of the total Agreement cost until completion of all work and submission to ARB by University of a final report (including computer diskette copy) approved in accordance with Exhibit F, by ARB. It is University's responsibility to submit an invoice in triplicate with the revised final report for ten percent withheld.

D. University will be paid for the payment period completed upon receipt, by ARB, of an invoice and progress report satisfying the requirements of this Agreement. The invoice and progress report must be deemed by ARB to reflect reasonable work performed in accordance with the Agreement.

E. The amount to be paid to University under this Agreement includes all sales and use taxes incurred pursuant to this Agreement. University shall not receive additional compensation for reimbursement of such taxes and shall not decrease work to compensate therefore.

Budget Submittal Form

This form is supplied for presenting budget detail to the Air Resources Board.

PLEASE TYPE OR PRINT:

Title of Proposal: Airborne and Ground Based Whole Air Sampling during CalNex 2010

Total Budget Requested: $447,456

Period Covered (months): 24

University: University of California, Irvine

Address: 300 University Tower
Irvine, CA 92697-4215

Name of person authorized to bind this bid:

Title: Judith Aguirre

Phone: 949 824 0446

Signature of person authorized to bind this bid: _____

Budget Summary

Budget details must be supplied on pages 3-11 and on additional pages if necessary.
Instructions and definitions of terms are provided in Attachment 1 of the Guidelines for Proposals.

NOTE: Totals in categories in this summary are automatically updated from pages 3-11 when using Excel file.

Direct Costs		
1.	Labor & Employee Fringe Benefits	$287,472
2.	Subcontractor(s)/Consultant(s)	$75,000
3.	Equipment	$0
4.	Travel & Subsistence	$5,000
5.	Electronic Data Processing	$0
6.	Photocopying & Printing	$0
7.	Mail, Telephone, and Fax	$0
8.	Materials & Supplies	$17,000
9.	Analyses	$0
10.	Miscellaneous	$30,000
	Total Direct Cost	**$414,472**

Indirect Costs		
11.	Overhead	$32,984
	Total Indirect Cost	**$32,984**

Total Direct and Indirect Cost:	**$447,456**

Budget Detail
I. Direct Costs

1a. Labor Charges for Universities and Other State Agencies

Note: Total Salary Requested cells automatically calculate when using Excel file.

	Individual's Name	Work Title	Mo. Salary	Est. Months	% of Effort or % of Salary	Total Salary Requested
A.	D. Blake	Professor	$17,635.00	1.50	100.00%	$26,452
B.	F. S. Rowland	Professor	$25,439.00	0.75	100.00%	$19,079
C.	N. Blake	Asst. Res.	$6,555.00	3.50	100.00%	$22,943
D.	S. Meinardi	Asst. Res.	$5,276.00	5.50	100.00%	$29,018
E.	I. Simpson	Asst. Spec.	$4,755.00	3.50	100.00%	$16,643
F.	B. Love	SRAII	$4,260.00	5.50	100.00%	$23,430
G.	G. Liu	Lab Asst	$2,692.00	5.50	100.00%	$14,806
H.	B. Chisholm	Adm. Analyst	$4,362.00	3.00	100.00%	$13,087
I.	B. Umber	GSR	$3,459.50	3.74	100.00%	$12,939
J.	M. Carlson	GSR	$3,459.50	3.74	100.00%	$12,939
K.	M. Yang	GSR	$3,749.00	6.74	100.00%	$25,268

(use additional page if necessary)

Subtotal: $216,602

Cost justifications. Describe exactly why each individual listed in the Budget Detail is needed in this project (i.e., their role in the project), why this particular person was chosen for this role, and why their proposed level of effort is necessary. Describe, for each position listed, why the specified rate is reasonable or competitive. (Use additional page if necessary).

Professor Donald R. Blake (PI and Project Manager) will direct the project. He will be responsible for coordinating the field sampling logistics, analysis of samples during the mission, and quality control of the resulting data. He will also coordinate laboratory logistics during the mission, including canister preparation and shipment, sample analysis, and data quality control and archiving. Once the data are archived he will oversee the data interpretation and journal article preparation. Professor Blake will also liaise with colleagues from other groups during the CalNex mission.

Professor F. Sherwood Rowland will advise on sampling strategy and be involved in the interpretation of initial results as they become available during the field deployment. Assistant researcher Simone Meinardi will participate in the research development process and will coordinate the calibration for each trace gas. He and graduate student Melissa Yang and Assistant researcher Nicola Blake will conduct the ground-level field sampling and the subsequent data analysis and preparation of manuscripts. Graduate students Matt Carlson and Brandon Umber will assist in sample analysis in the UCI laboratory. Associate specialist Isobel Simpson will assist in data interpretation and manuscript preparation. Technicians Brent Love and Gloria Liu will prepare each canister for field deployment. They will analyze each sample, modify the resulting chromatograms, and assemble the data into a usable format. Assistant analyst Barbara Chisholm will be responsible for logistical management throughout the CalNex field project. She will also be in charge of shipping canisters and maintaining communication between the field scientists and the UCI laboratory.
Salary projections for all the above mentioned participants increase 2.5%/year for cost of living on 10/1 anniversary date. I. Simpson and S. Meinardi salaries include a 5% merit increase in year two on 7/1 anniversary date.

1b. Fringe Benefits

Note: COST cells automatically calculate when using Excel file.

	Individual's Name	BASE ($)	RATE (%)		COST
A.	D. Blake	$26,452.00	16.70%		$4,417
B.	F. S. Rowland	$19,079.00	16.70%		$3,186
C.	N. Blake	$22,943.00	21.00%		$4,818
D.	S. Meinardi	$29,018.00	21.00%		$6,094
E.	I. Simpson	$16,643.00	21.00%		$3,495
F.	B. Love	$23,430.00	26.00%		$6,092
G.	G. Liu	$14,806.00	26.00%		$3,850
H.	B. Chisholm	$13,087.00	26.00%		$3,403
I.	B. Umber	$12,939.00	1.30%	3.00%	$211
J.	M. Carlson	$12,939.00	1.30%	3.00%	$211
K.	M. Yang	$25,268.00	1.30%	3.00%	$468
L.	GSR fees	$34,626.00			$34,626
(use additional page if necessary)					

Subtotal: $70,870

Cost justifications. Provide the Basis for the Fringe Benefit Rates. (Use additional page if necessary).

The listed benefit rates are those dictated by UC Regents.
The benefit rate for the graduate students are 3% in the summer and 1.3% during the academic year. Graduate Student fees for the Graduate Students are $5,355 for Year 1 and $29,271 for Year 2. Graduate Student fees are required and are considered a benefit.

2. Subcontractors & Consultants

List all subcontractors and consultants. **Also submit separate Budget Submittal Form for each subcontractor and consultant.**

	Subcontractor or consultant	Cost
A.	Subcontract with the University of Miami	$75,000
B.		
C.		
D.		
(use additional page if necessary)		

Subtotal: $75,000

Cost justifications. Describe exactly why each subcontractor is needed in this project (i.e., their role in the project). Describe, for each subcontractor, why the specified rate is reasonable or competitive. (Use additional page if necessary).

Prof. Elliot Atlas will collect 72 whole air samples per flight aboard the NOAA WP-3. The sampling interval will depend on the duration of the flight. For example an 8-hour flight allows a sample to be collected every 6-7 minutes, and a 6-hour flight allows a sample every 5 minutes. Sample collection on board the aircraft will be coordinated with other experiments and any intercomparison activities, so as to optimize sample overlap with other groups.

3. Equipment (Itemize)

	Item	Cost
A.		
B.		
C.		
D.		

Subtotal: $0

Cost justifications. Describe exactly why each listed equipment item is needed in this project, and why the cost is reasonable. (Use additional page if necessary).
(Refer to Exhibit E, page 19)

4. Travel and Subsistence (Itemize). Use State Rates (Appendix IV). NO FOREIGN TRAVEL ALLOWED.

	Description	Cost
A.	Air transportation	$1,800
B.	Ground transportation	$300
C.	Per diem or subsistence	$1,500
D.	Other (Lodging & Parking)	$1,400

Subtotal: $5,000

Cost justifications. Describe the purpose and duration of each trip and explain why the travel is necessary. (Use additional page if necessary).

Three people will attend data meetings. We are estimating that each person will require $600 for air fare, $100 for ground transportation, $300 for subsistence, and $466.67 for lodging for a 5 day meeting.

5. Electronic Data Processing (Itemize)

	Description	Cost
A.		
B.		
C.		
D.		

Subtotal: $0

Cost justifications. Explain the need for the expenditure and the basis for the costs. (Use additional page if necessary).

6. Photocopying & Printing (Itemize)

	Description of product	Cost
A.		
B.		

Subtotal: $0

Cost justifications. Explain the need for the expenditure and the basis for the costs. (Use additional page if necessary).

7. Mail, Telephone & Fax (Itemize)

	Item	Cost
A.		
B.		
C.		

Subtotal: $0

Cost justifications. Explain the need for the expenditure and the basis for the costs. (Use additional page if necessary).

8. Materials & Supplies (Itemize)

	Item	Cost
A.	30,000 liters of liquid nitrogen at $.40/liter	$12,000
B.	Calibration standard gas	$5,000
C.		

Subtotal: $17,000

Cost justifications. Describe exactly why each item listed above is needed in this project. Explain why the proposed cost is reasonable. (Use additional page if necessary).

Liquid nitrogen is necessary to complete the gas chromatograph analysis of the air samples. We are estimating the 30,000 liters will be necessary to take X samples.

Calibration standard gas is necesary to calibrate the Gas chromatographs. This step is needed to obtain accurate concentration data for completion of all sample analysis.

9. Analyses (Itemize)

	Description	Cost
A.		
B.		
C.		
D.		

Subtotal: $0

Cost justifications. Describe the purpose of each different analysis and explain why it is needed in this project. Explain why the proposed rate is reasonable. (Use additional page if necessary).

10. Miscellaneous (Itemize)

	Item	Cost
A.	shipping canisters	$30,000
B.		
C.		

Subtotal: $30,000

Cost justifications. Justify all costs not included in the categories above. Explain the need for the expenditure and the basis for the costs. (Use additional page if necessary).

We are estimating that it will cost $30,000 to ship canisters back and forth from the field. We are required to use federal express, or some other overnight carrier, to insure timely delivery of empty canisters to the field, and acquired samples to the laboratory.

Total Direct Costs (add subtotals for categories 1-10): $414,473

II. Indirect Costs

11. Overhead and Other Indirect Costs

	Base (Salaries, total direct costs, etc.) ($)	Rate (%)	Cost
A.	$329,846.00	10.00%	$32,984
B.			$0
C.			$0

Subtotal: $32,984

Total Indirect Cost: $32,984

Total Project Cost: $447,456

UNIVERSITY OF Miami

December 15, 2008

Dr. Donald R. Blake
Professor of Chemistry
Dept. of Chemistry - UCI
516 Rowland Hall
Irvine, CA 92697

Dear Dr. Blake,

With this note, the Rosenstiel School of Marine and Atmospheric Science at the University of Miami confirm it's commitment to participate in the project entitled "Sampling and Analysis of VOCs and GHSs from the NOAA p3 Aircraft during CalNex" with a budget of $75,000 for the initial year. The commitment of Dr. Elliot Atlas, Professor, will continue throughout the project duration.

Please contact Soraida Diaz, the administrative point of contact at aida.diaz@miami.edu at UM- RSMAS. We look forward to our continue collaboration with ICI.

Respectfully yours,

Otis B. Brown, Dean
Rosenstiel School of Marine &
Atmospheric Science

Please remit payment to:

University of Miami
Sponsored Programs
P.O. Box. 025405
Miami, Florida 33102-5405

Please send correspondence to:

Rosenstiel School of Marine and Atmospheric Science
Sponsored Programs Administration
4600 Rickenbacker Causeway
Miami, Florida 33149-1031
Office: 305-421-4800
Fax: 305-421-4876

University of Miami – Dr. Elliot Atlas

Sampling and Analysis of VOCs and GHSs from the NOAA p3 Aircraft during CalNex

05/01/2009- 04/30/2010

Scope of Work:

The work done at the University of Miami will be supervised by Dr. Elliot Atlas. He will work with his research staff on the following tasks:

1) Analytical method development in collaboration with the Blake laboratory at UC-Irvine. Details of analysis of target compounds will be finalized and standards will be prepared and tested.

2) Sampler modification. We will work with the NOAA aircraft group to make necessary modifications to the whole air sampler that will be used during the CalNex mission. It is expected that the UM/UCI group will deploy the Advanced Whole Air Sampler (AWAS) instrument that was jointly developed for the NSF Gulfstream V aircraft. Actual machining costs for rack construction will be covered by the NOAA group.

3) Canister preparations. We will work with the UC-Irvine group to prepare the canisters for use during the actual CalNex mission. 4) Develop analytical interface. We will build the necessary control modules that will be used to interface the AWAS sample canisters to the UC-Irvine trace gas analytical system.

Budget Justification:

The budget covers costs associated with preparing the sampling and analytical facilities for trace gas studies during CalNex. Dr. Elliot Atlas will supervise the work at the University of Miami and will be the person who will collaborate with the UCI-Blake laboratory on analytical aspects of the program. Dr. X. Zhu will work in the UM laboratory to prepare and evaluate standard gases for the program and will assist in general laboratory operations. Mr. Rich Lueb will interface with the NOAA engineers to construct appropriate aircraft mounting and installation of the Whole Air Sampler on the NOAA P3. An electronics engineer (TBD) will provide support for any software changes to the existing control program and will ensure that the Whole Air Sampler computer is appropriately interfaced with the aircraft communication system. In addition to the salary costs associated with the activities just described, the budget includes travel costs for Dr. Atlas to do collaborative work in the Blake laboratory. Normal costs of laboratory consumables (gases, fittings, cryogen, etc.) and shipping (flask packages, etc.) are also included in the budget.

PROJECT DATE: 05/01/2009-04/30/2010
PROJECT TITLE: Sampling and Analysis of VOCs and GHSs from the NOAA p3 Aircraft during CalNex

	YEAR 1		
	months	%	AMOUNT
Principal Investigator:			
1 Eliot Atlas	1.3	10%	18,624
Supporting Personnel			
1 Xiaorong Zhu	1.0	8%	4,864
2 R. Lueb	1.0	8%	6,858
3 Eng. TBA	0.5	4%	3,693
TOTAL SALARIES			34,039
4. Fringe Benefits			8,892
TOTAL SALARIES & FRINGE BENEFITS			42,930
Expendable Equipment/ Mis equp			2,000
Travel Domestic			
Year 1 (7 days)	travel to UCI		2,500
Year 2 (56 days)			
2 week integration (2 people 2 RT air); 6 weeks in field (2 people at airplane and/or UCI)			
Year 3 (meeting)	one week		
Other Direct Costs:			
Technical supplies			1,000
Computer/Connect charges			
Shipping Costs			430
Modified Total Direct Costs:			48,860
Indirect Costs		53.5%	26,140
Capital Equipment-No Indirect			
TOTAL PROJECT COSTS			75,000

EXHIBIT D

SPECIAL TERMS AND CONDITIONS

1. Termination

A. This Agreement may be canceled at any time by either party, upon thirty (30) days written notice to the other party.

B. In the case of early termination, the performing agency will submit an invoice in triplicate and a report in triplicate covering services to termination date, following the invoice and progress report requirements of this Agreement. A copy and description of any data collected up to termination date will also be provided to ARB.

C. Upon receipt of the invoice, progress report, and data, a final payment will be made to the performing agency. This payment shall be for all ARB-approved, actually incurred costs in accordance with Exhibits A and B, and shall include labor, and materials purchased or utilized (including all non-cancelable commitments) to termination date, and pro rata indirect costs as specified in the proposal budget.

2. Disputes

A. ARB reserves the right to issue an order to stop work in the event that a dispute should arise, or in the event that the ARB gives the performing agency a notice that this Agreement will be terminated. The stop-work order will be in effect until the dispute has been resolved or this Agreement has been terminated.

B. Any dispute concerning a question of fact arising under the terms of this Agreement which is not disposed of within a reasonable period of time by agency employees normally responsible for the administration of this agreement, shall be brought to the attention of the Executive Officer or designated representative of each agency for joint resolution.

3. Amendments

ARB reserves the right to amend this agreement for additional time and/or additional funding.

EXHIBIT E

ADDITIONAL PROVISIONS

1. Reports and Data Compilations

A. With respect to each invoice period, University shall forward to the ARB Contract Administrator, one (1) electronic copy of the progress report and mail one (1) copy of the progress report along with each invoice. (Do not use Express Mail). When emailing the progress report, the "subject line" should state the contract number and the billing period. Each progress report will begin with the following disclaimer:

The statements and conclusions in this report are those of the University and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

B. Each progress report will also include:

1. A brief narrative account of project tasks completed or partially completed since the last progress report;

2. A brief discussion of problems encountered during the reporting period and how they were or are proposed to be resolved;

3. A brief discussion of work planned, by project task, before the next progress report; and

4. A graph or table showing allocation of the budget and amount used to date.

5. A graph or table showing percent of work completion for each task.

C. If the project is behind schedule, the progress report must contain an explanation of reasons and how the University plans to resume the schedule.

D. Six months prior to Agreement termination date, University will deliver to ARB twenty (20) bound copies of a draft final report. The reports may be stapled or spiral bound, depending on size. The draft final report will conform to Exhibit F.

EXHIBIT E

E. Within forty-five (45) days of receipt of ARB's comments on the draft Final Report (Exhibit F), University will deliver to ARB's Contract Manager two (2) copies of the Final Report incorporating all reasonable alterations and additions requested by ARB. Upon approval of the amended final report approved by ARB in accordance to Exhibit F, University will within two (2) weeks, deliver to ARB two (2) camera ready UNBOUND originals of a Final Report incorporating all final alterations and additions. The final report will conform to the Contract Final Report Format, Exhibit F.

F. Together with the final report, University will deliver a copy of the report on diskette/CD, using any common word processing software (please specify the software used) and a set of all data compilations as specified by the ARB Contract Manager.

G. University's obligation under this Agreement shall be deemed discharged only upon submittal to ARB of an acceptable final report in accordance to Exhibit F, report diskette/CD, all required data compilations, and any other project deliverables.

H. Prior to completion of this Agreement, University shall be entitled to release or make available reports, information, or other data prepared or assembled by it pursuant to this Agreement, in scientific journals and other publications and at scientific meetings, provided however, that a copy of the publication be submitted to ARB for review and comment 45 days prior to such publication. Further, University shall place the disclaimer statement in a conspicuous place on all such reports or publications. Health related reports should include an acknowledgment to the late Dr. Friedman. Nothing in this provision shall be construed to limit the right of State to release information obtained from the University or to publish reports, information, or data in State publications.

2. <u>Copyrightable Materials</u>

In recognition of the policy of ARB and University to promote and safeguard free and open inquiry by faculty, students and the members of the public and in furtherance of such policy, both parties agree to the following with respect to rights in data and copyrights under this Agreement:

EXHIBIT E

A. The term "Subject Data" shall mean all original and raw research data, notes, computer programs, writings, sound recordings, pictorial reproductions, drawings or other graphical representations, and works of any similar nature, produced by University in

performance of this Agreement, but specifically excluding "Reports," as defined in this Agreement. Subject Data also excludes financial reports, cost analyses, and similar information incidental to contract administration.

B. The term "Reports" shall have the meaning assigned to it in this Exhibit F of this Agreement.

C. Ownership of all Subject Data and copyrights arising from Subject Data shall be vested in University while ownership of all Reports and copyrights arising from the Reports delivered under this Agreement shall be vested in ARB. University agrees to make available to the public for public benefit, to the extent the University shall have the legal right to do so, without license or fee, any scholarly articles which are published from the Subject Data.

D. Nothing in this exhibit or Agreement shall be construed to limit the right of University faculty, students or staff to publish the Subject Data in the form of scholarly articles in academic journals nor to affect, abrogate or limit the right of University faculty, staff or students to make use of the Subject Data.

3. <u>Travel & Per Diem</u>

A. Any reimbursement for necessary travel and per diem shall be at the University's approved travel rates.

B. No foreign travel shall be reimbursed unless prior written authorization is obtained from ARB.

4. <u>Meetings</u>

A. <u>Initial meeting</u>. Before work on the contract begins, the Principal Investigator and key personnel will meet with the ARB Contract Manager and other staff to discuss the overall plan, details of performing the tasks, the project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin.

EXHIBIT E

B. Progress review meetings. The Principal Investigator and appropriate members of his or her staff will meet with ARB's Contract Manager at quarterly intervals to discuss the progress of the project. This meeting may be conducted by phone.

C. Technical Seminar. The Contractor will present the results of the project to ARB staff and a possible web cast at a seminar at ARB facilities in Sacramento or El Monte.

5. Confidentiality

A. It is understood that in the course of carrying out this Agreement, State may wish to provide University with proprietary or confidential information of State (Proprietary Information). University agrees to use its best efforts to hold proprietary information in confidence and shall return it to State upon the completion of the project.

B. This obligation shall apply only to proprietary information that is designated or identified as such in writing by State prior to the disclosure thereof. All proprietary information shall be sent only to the Principal Investigator. Moreover, this obligation shall not apply to any proprietary information which: a) is or becomes publicly known through no wrongful or negligent act on the part of University; b) is already known to University at the time of disclosure; c) independently developed by University without breach of this agreement; or d) is generally disclosed to third parties by State without similar restrictions on such third parties.

EXHIBIT F

RESEARCH FINAL REPORT FORMAT

The research contract Final Report (Report) is as important to the contract as the research itself. The Report is a record of the project and its results, and is used in several ways. Therefore, the Report must be well organized and contain certain specific information. The ARB's Research Screening Committee (RSC) reviews all draft Final Reports, paying special attention to the Abstract and Executive Summary. If the RSC finds that the Report does not fulfill the requirements stated in this Appendix, the document will not be approved for release, and final payment for the work completed may be withheld. This Appendix outlines the requirements that must be met when producing the Report.

Note: In partial fulfillment of the Final Report requirements, the Contractor shall submit a copy of the Report on a CD in PDF format and in a word-processing format, preferably in Word - Version 6.0 or later. This is in addition to the submission of any paper copies required. The diskette shall be clearly labeled with the contract title, ARB contract number, the words "Final Report", and the date the report was submitted.

Legibility. Each page of the approved Final Report must be legible and camera-ready.

Binding. The draft Report, including its appendices, must be either spiral bound or stapled, depending on size. The revised Report and its appendices should be spiral bound, except for two unbound, camera-ready originals.

Cover. Do not supply a cover for the Report. The ARB will provide its standard cover.

One-sided vs. two-sided. To conserve paper, both the draft Report and the revised Report, except for the unbound camera-ready copies, should be printed on both sides of the page. The unbound camera-ready copies must be printed on only one side of the page.

Title. The title of the Report should exactly duplicate the title of the contract unless a change is approved in writing by the contract manager.

Spacing. In order to conserve paper, copying costs, and postage, please use single or one-line (1) spacing.

Page size. All pages should be of standard size (8 ½" x 11") to allow for photo-reproduction.

EXHIBIT F

Large tables or figures. Foldout or photo-reduced tables or figures are not acceptable because they cannot be readily reproduced. Large tables and figures should be presented on consecutive
8 ½" x 11" pages, each page containing one portion of the larger chart.

Color. Color presentations are not acceptable; printing shall be black on white only.

Corporate identification. Do not include corporate identification on any page of the Final Report, except the title page.

Unit notation. Measurements in the Reports should be expressed in metric units. However, for the convenience of engineers and other scientists accustomed to using the British system, values may be given in British units as well in parentheses after the value in metric units. The expression of measurements in both systems is especially encouraged for engineering reports.

Section order. The Report should contain the following sections, in the order listed below:

Title page
Disclaimer
Acknowledgment (1)
Acknowledgment (2)
Table of Contents
List of Figures
List of Tables
Abstract
Executive Summary
Body of Report
References
List of inventions reported and copyrighted materials produced
Glossary of Terms, Abbreviations, and Symbols
Appendices

Page numbering. Beginning with the body of the Report, pages shall be numbered consecutively beginning with "1", including all appendices and attachments. Pages preceding the body of the Report shall be numbered consecutively, in ascending order, with small Roman numerals.

Title page. The title page should include, at a minimum, the contract number, contract title, name of the principal investigator, contractor organization, date,

EXHIBIT F

and this statement: "Prepared for the California Air Resources Board and the California Environmental Protection Agency"

Disclaimer. A page dedicated to this statement must follow the Title Page:

The statements and conclusions in this Report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

Acknowledgment (1). Only this section should contain acknowledgments of key personnel and organizations who were associated with the project. The last paragraph of the acknowledgments must read as follows:

This Report was submitted in fulfillment of [ARB contract number and project title] by [contractor organization] under the [partial] sponsorship of the California Air Resources Board. Work was completed as of [date].

Acknowledgment (2). Health reports should include an acknowledgment to the late Dr. Friedman. Reports should include the following paragraph:

This project is funded under the ARB's Dr. William F. Friedman Health Research Program. During Dr. Friedman's tenure on the Board, he played a major role in guiding ARB's health research program. His commitment to the citizens of California was evident through his personal and professional interest in the Board's health research, especially in studies related to children's health. The Board is sincerely grateful for all of Dr. Friedman's personal and professional contributions to the State of California.

Table of Contents. This should list all the sections, chapters, and appendices, together with their page numbers. Check for completeness and correct reference to pages in the Report.

List of Figures. This list is optional if there are fewer than five illustrations.

List of Tables. This list is optional if there are fewer than five tables.

Abstract. The abstract should tell the reader, in non-technical terms, the purpose and scope of the work undertaken, describe the work performed, and present the results obtained and conclusions. The purpose of the abstract is to provide the reader with useful information and a means of determining whether the complete document should be obtained for study. The length of the abstract should be no

EXHIBIT F

more than about 200 words. Only those concepts that are addressed in the executive summary should be included in the abstract.

Example of an abstract:

A recently developed ground-based instrument, employing light detecting and ranging (lidar) technology, was evaluated and found to accurately measure ozone concentrations at altitudes of up to 3,000 meters. The novel approach used in this study provides true vertical distributions of ozone concentrations aloft and better temporal coverage of these distributions than other, more common methods, such as those using aircraft and ozone sonde (balloon) techniques. The ozone and aerosol measurements from this study, in conjunction with temperature and wind measurements, will provide a better characterization of atmospheric conditions aloft and the processes involved in the formation of unhealthful ozone concentrations than can be achieved with traditional ground-based monitors.

Executive Summary. The function of the executive summary is to inform the reader about the important aspects of the work that was done, permitting the reader to understand the research without reading the entire Report. It should state the objectives of the research and briefly describe the experimental methodology[ies] used, results, conclusions, and recommendations for further study. All of the concepts brought out in the abstract should be expanded upon in the Executive Summary. Conversely, the Executive Summary should not contain concepts that are not expanded upon in the body of the Report.

The Executive Summary will be used in several applications as written; therefore, please observe the style considerations discussed below.

Limit the Executive Summary to two pages, single spaced.

Use narrative form. Use a style and vocabulary level comparable to that in Scientific American or the New York Times.

Do not list contract tasks in lieu of discussing the methodology.

Discuss the results rather than listing them.

Avoid jargon.

Define technical terms.

Use passive voice if active voice is awkward.

EXHIBIT F

Avoid the temptation to lump separate topics together in one sentence to cut down on length.

The Executive Summary should contain four sections: Background, Methods, Results, and Conclusions, described below.

THE BACKGROUND SECTION. For the Background, provide a one-paragraph discussion of the reasons the research was needed. Relate the research to the Board's regulatory functions, such as establishing ambient air quality standards for the protection of human health, crops, and ecosystems; the improvement and updating of emissions inventories; and the development of air pollution control strategies.

THE METHODS SECTION. At the beginning of the Methods section, state what was done in general, in one or two sentences.

The methodology should be described in general, nontechnical terms, unless the purpose of the research was to develop a new methodology or demonstrate a new apparatus or technique. Even in those cases, technical aspects of the methodology should be kept to the minimum necessary for understanding the project. Use terminology with which the reader is likely to be familiar. If it is necessary to use technical terms, define them. Details, such as names of manufacturers and statistical analysis techniques, should be omitted.

Specify when and where the study was performed, if it is important in interpreting the results.

The findings should not be mentioned in the Methods section.

THE RESULTS SECTION. The Results section should be a single paragraph in which the main findings are cited and their significance briefly discussed. The results should be presented as a narrative, not a list. This section must include a discussion of the implications of the work for the Board's relevant regulatory programs.

THE CONCLUSIONS SECTION. The Conclusions section should be a single short paragraph in which the results are related to the background, objectives, and methods. Again, this should be presented as a narrative rather than a list. Include a short discussion of recommendations for further study, adhering to the guidelines for the Recommendations section in the body of the Report.

Body of Report. The body of the Report should contain the details of the research, divided into the following sections:

EXHIBIT F

INTRODUCTION. Clearly identify the scope and purpose of the project. Provide a general background of the project. Explicitly state the assumptions of the study.

Clearly describe the hypothesis or problem the research was designed to address. Discuss previous related work and provide a brief review of the relevant literature on the topic.

MATERIALS AND METHODS. Describe the various phases of the project, the theoretical approach to the solution of the problem being addressed, and limitations to the work. Describe the design and construction phases of the project, materials, equipment, instrumentation, and methodology. Describe quality assurance and quality control procedures used. Describe the experimental or evaluation phase of the project

RESULTS. Present the results in an orderly and coherent sequence. Describe statistical procedures used and their assumptions. Discuss information presented in tables, figures and graphs. The titles and heading of tables, graphs, and figures, should be understandable without reference to the text. Include all necessary explanatory footnotes. Clearly indicate the measurement units used.

DISCUSSION. Interpret the data in the context of the original hypothesis or problem. Does the data support the hypothesis or provide solutions to the research problem? If appropriate, discuss how the results compare to data from similar or related studies. What are the implications of the findings? Identify innovations or development of new techniques or processes. If appropriate, discuss cost projections and economic analyses.

SUMMARY AND CONCLUSIONS. This is the most important part of the Report because it is the section that will probably be read most frequently. This section should begin with a clear, concise statement of what, why, and how the project was done. Major results and conclusions of the study should then be presented, using clear, concise statements. Make sure the conclusions reached are fully supported by the results of the study. Do not overstate or over interpret the results. It may be useful to itemize primary results and conclusions. A simple table or graph may be used to illustrate.

RECOMMENDATIONS. Use clear, concise statements to recommend (if appropriate) future research that is a reasonable progression of the study and can be supported by the results and discussion.

References. Use a consistent style to fully cite work referenced throughout the Report and references to closely related work, background material, and publications that offer additional information on aspects of the work. Please list

EXHIBIT F

these together in a separate section, following the body of the Report. If the Report is lengthy, you may list the references at the end of each chapter.

List of inventions reported and publications produced. If any inventions have been reported, or publications or pending publications have been produced as a result of the project, the titles, authors, journals or magazines, and identifying numbers that will assist in locating such information should be included in this section.

Glossary of terms, abbreviations, and symbols. When more than five of these items are used in the text of the Report, prepare a complete listing with explanations and definitions. It is expected that every abbreviation and symbol will be written out at its first appearance in the Report, with the abbreviation or symbol following in parentheses [i.e., carbon dioxide (CO_2)]. Symbols listed in table and figure legends need not be listed in the Glossary.

Appendices. Related or additional material that is too bulky or detailed to include within the discussion portion of the Report shall be placed in appendices. If a Report has only one appendix, it should be entitled "APPENDIX". If a Report has more than one appendix, each should be designated with a capital letter (APPENDIX A, APPENDIX B). If the appendices are too large for inclusion in the Report, they should be collated, following the binding requirements for the Report, as a separate document. The contract manager will determine whether appendices are to be included in the Report or treated separately. Page numbers of appendices included in the Report should continue the page numbering of the Report body. Pages of separated appendices should be numbered consecutively, beginning at "1".