

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: LAWRENCE BERKELEY NATIONAL
LABORATORY

RESOLVED, that the State Energy Resources Conservation and Development Commission (Energy Commission) approves Amendment 1 to Contract 500-09-042 with the Department of Energy, Lawrence Berkeley National Laboratory, to add \$1 million and extend the contract 12 months to March 31, 2016. The project is intended to improve energy efficiency and indoor air quality in California homes with gas appliances through research to develop methods to reduce indoor air pollution from combustion products. (PIER natural gas funding.)

FURTHER BE IT RESOLVED, that this document authorizes the Executive Director to execute the same on behalf of the Energy Commission.

CERTIFICATION

The undersigned Secretariat to the Commission does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly adopted at a meeting of the California Energy Commission held on February 8, 2012.

AYE: [List of Commissioners]

NAY: [List of Commissioners]

ABSENT: [List of Commissioners]

ABSTAIN: [List of Commissioners]

Harriet Kallemeyn,
Secretariat

CONTRACT REQUESTS FORM (CRF)

CEC-94 (Revised 5/11)

CALIFORNIA ENERGY COMMISSION


 New Contract _____ Amendment to Existing Contract: 500-09-042 Amendment Number: 1

Division	Contract Manager:	MS-	Phone	CM Training Date
Energy Research and Development	Marla Mueller	43	916-327-1716	8/19/2002

Contractor's Legal Name	Federal ID Number
DOE- Lawrence Berkeley National Laboratory	94-2951741

Title of Project
Healthy Homes - Exposure to Unvented Combustion Gases

Term	Start Date	End Date	Amount
New/Original Contract	6/7/2010	3/31/2015	\$ 1,263,300

Line up the Amendment information as best as possible within the following table.

Amendment #	End Date (mm/dd/yy)	Amount
Amendment 1	3/31/2016	\$1,000,000

Business Meeting Information

Proposed Business Meeting Date	4/11/2012	<input type="checkbox"/> Consent	<input checked="" type="checkbox"/> Discussion
Business Meeting Presenter	Marla Mueller	Time Needed:	5 minutes

Agenda Item Subject and Description

Possible approval of Amendment 1 to Contract 500-09-042 with Lawrence Berkeley National Laboratory to extend this contract by 12 months and add \$1,000,000 to synergistically improve energy efficiency and indoor air quality in California homes with gas appliances through research to develop methods to reduce indoor air pollution from combustion products. Contact: Marla Mueller

Business Meeting approval is not required for the following types of contracts: *Executive Director's signature is required in all cases.*

- Contracts less than \$10k (*Policy Committee's signature is also required*)
- Amendment for a no-cost time extension. Must be first extension, less than one year and original contract less than \$100k.
- Contracts less than \$25k for Expert Witness in Energy Facility licensing cases and amendments.

Purpose of Contract or Purpose of Amendment, if applicable

The purpose of this amendment is to extend the contract term another 12 months and to increase funding for this contract an additional \$1,000,000. This amendment expands the scope and allows more time to address measures to reduce or prevent combustion gases in the indoor environment. The amended contract will focus on three main areas: (1) measurement of time-resolved pollutant concentrations in homes that use natural gas cooking burners on a daily basis, and assessment of the benefits of using venting range hoods in these homes, (2) development and application of test methods to provide guidance on range hood effectiveness and energy efficiency, and (3) research to support development of a combustion safety diagnostic protocol that will enable more effective and extensive air sealing of homes with natural draft gas appliances. This research will develop reliable scientific data that can be used by regulators, policy makers, and industry in developing standards, guidelines, and regulations.

California Environmental Quality Act (CEQA) Compliance

- Is Contract considered a "Project" under CEQA?
 - Yes: skip to question 2
 - No: complete the following (PRC 21065 and 14 CCR 15378):
 Explain why contract is not considered a "Project":
 Contract will not cause direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because it involves surveys and/or field studies of homes.
- If contract is considered a "Project" under CEQA:
 - a) Contract **IS** exempt. (Draft NOE required)
 - Statutory Exemption. List PRC and/or CCR section number: _____
 - Categorical Exemption. List CCR section number: _____
 - Common Sense Exemption. 14 CCR 15061 (b) (3)
 Explain reason why contract is exempt under the above section: _____
 - b) Contract **IS NOT** exempt. The Contract Manager needs to consult with the Energy Commission attorney assigned to their division and the Siting Office regarding a possible Initial Study.

CONTRACT REQUESTS FORM (CRF)

CEC-94 (Revised 5/11)

CALIFORNIA ENERGY COMMISSION



Budgets Information								
Contract Amount Funded		Breakdown by FY			Funding Sources			
Funding Source	Amount	FY	Amount	Approved?	Funding Source	FY	Budget List No.	Amount
ARFVTF	\$	11-12	\$1,000,000	Yes	NG Subaccount, PIERDD	10-11	501.001E	\$1,000,000
ECAA	\$		\$					\$
State- ERPA	\$		\$					\$
Federal	\$		\$					\$
PIER - E	\$		\$					\$
PIER - NG	\$1,000,000		\$					\$
Reimbursement	\$		\$					\$
Other	\$		\$					\$
TOTAL: \$1,000,000		TOTAL: \$1,000,000			TOTAL:			\$1,000,000
Reimbursement Contract #:					Federal Agreement			

Contractor's Administrator/ Officer		Contractor's Project Manager	
Name:	Betsy Quayle	Name:	Brett Singer
Address:	1 CYCLOTRON RD BLDG 90R2000	Address:	1 Cyclotron Rd, MS 90-3111
City, State, Zip:	BERKELEY, CA 94720-8130	City, State, Zip:	Berkeley, CA 94720-8134
Phone/ Fax:	510-486-7391 / 510-486-4673	Phone/ Fax:	510-486-4779 / 510-486-5928
E-Mail:	bequayle@lbl.gov	E-Mail:	bcsinger@lbl.gov

Contractor Is
<input type="checkbox"/> Private Company (including non-profits)
<input type="checkbox"/> CA State Agency (including UC and CSU)
<input checked="" type="checkbox"/> Government Entity (i.e. city, county, federal government, air/water/school district, joint power authorities, university from another state)

Selection Process Used
<input type="checkbox"/> Solicitation _____ Solicitation #: _____ # of Bids: _____ Low Bid? <input type="checkbox"/> No <input type="checkbox"/> Yes
<input type="checkbox"/> Non Competitive Bid (Attach CEC 96)
<input checked="" type="checkbox"/> Exempt Other Government Entity

Civil Service Considerations
<input type="checkbox"/> Not Applicable (Contract is with a CA State Entity or a membership/co-sponsorship)
<input checked="" type="checkbox"/> Public Resources Code 25620, et seq., authorizes the Commission to contract for the subject work. (PIER)
<input type="checkbox"/> The Services Contracted:
<input type="checkbox"/> are not available within civil service
<input type="checkbox"/> cannot be performed satisfactorily by civil service employees
<input type="checkbox"/> are of such a highly specialized or technical nature that the expert knowledge, expertise, and ability are not available through the civil service system.
<input type="checkbox"/> The Services are of such an:
<input type="checkbox"/> urgent
<input type="checkbox"/> temporary, or
<input type="checkbox"/> occasional nature
that the delay to implement under civil service would frustrate their very purpose.
Justification:
Public Resources Code 25620, et seq., authorizes the Commission to contract for the subject work. (PIER)

CONTRACT REQUESTS FORM (CRF)



Payment Method			
<input type="checkbox"/>	A. Reimbursement in arrears based on:		
<input type="checkbox"/>	Itemized Monthly	<input type="checkbox"/>	Itemized Quarterly
<input type="checkbox"/>		<input type="checkbox"/>	Flat Rate
<input type="checkbox"/>			One-time
<input checked="" type="checkbox"/>	B. Advanced Payment		
<input type="checkbox"/>	C. Other, explain:		

Retention			
1.	Is contract subject to retention?	<input checked="" type="checkbox"/>	No
		<input type="checkbox"/>	Yes
	If Yes, Do you plan to release retention prior to contract termination?	<input type="checkbox"/>	No
		<input type="checkbox"/>	Yes

Justification of Rates
The contract price is reasonable, particularly considering the facility provided by the contract terms. The research will be conducted by a national laboratory; salaries and wages are in accordance with costing practice for all Department of Energy programs.

Disabled Veteran Business Enterprise Program (DVBE)	
1.	<input checked="" type="checkbox"/> Not Applicable
2.	<input type="checkbox"/> Meets DVBE Requirements DVBE Amount:\$ _____ DVBE %: _____
	<input type="checkbox"/> Contractor is Certified DVBE
	<input type="checkbox"/> Contractor is Subcontracting with a DVBE: _____
3.	<input type="checkbox"/> Requesting DVBE Exemption (attach CEC 95)

Is Contractor a certified Small Business (SB), Micro Business (MB) or DVBE?		<input checked="" type="checkbox"/>	No	<input type="checkbox"/>	Yes
If yes, check appropriate box:		<input type="checkbox"/>	SB	<input type="checkbox"/>	MB
		<input type="checkbox"/>	DVBE		

Is Contractor subcontracting any services?		<input checked="" type="checkbox"/>	No	<input type="checkbox"/>	Yes
If yes, give company name and identify if they are a Small Business (SB), Micro Business (MB) and/or DVBE:					

Miscellaneous Contract Information			
1.	Will there be Work Authorizations?	<input checked="" type="checkbox"/>	No
		<input type="checkbox"/>	Yes
2.	Is the Contractor providing confidential information?	<input checked="" type="checkbox"/>	No
		<input type="checkbox"/>	Yes
3.	Is the contractor going to purchase equipment?	<input checked="" type="checkbox"/>	No
		<input type="checkbox"/>	Yes
4.	Check frequency of progress reports		
	<input type="checkbox"/> Monthly <input checked="" type="checkbox"/> Quarterly <input type="checkbox"/> _____		
5.	Will a final report be required?	<input type="checkbox"/>	No
		<input checked="" type="checkbox"/>	Yes
6.	Is the contract, with amendments, longer than a year? If yes, why?	<input type="checkbox"/>	No
		<input checked="" type="checkbox"/>	Yes
The Department of General Services has agreed to give the Commission blanket authority to execute multi-year contracts to support the Commission's RD&D Programs.			

CONTRACT REQUESTS FORM (CRF)



The following items should be attached to this CRF			
1. Scope of Work, Attach as Exhibit A.	<input type="checkbox"/>	N/A	<input checked="" type="checkbox"/> Attached
2. Budget Detail, Attach as Exhibit B.	<input type="checkbox"/>	N/A	<input checked="" type="checkbox"/> Attached
3. CEC 96, NCB Request	<input checked="" type="checkbox"/>	N/A	<input type="checkbox"/> Attached
4. CEC 30, Survey of Prior Work	<input checked="" type="checkbox"/>	N/A	<input type="checkbox"/> Attached
5. CEC 95, DVBE Exemption Request	<input checked="" type="checkbox"/>	N/A	<input type="checkbox"/> Attached
6. Draft CEQA Notice of Exemption (NOE)	<input checked="" type="checkbox"/>	N/A	<input type="checkbox"/> Attached
7. Resumes	<input checked="" type="checkbox"/>	N/A	<input type="checkbox"/> Attached
8. CEC 105, Questionnaire for Identifying Conflicts			<input checked="" type="checkbox"/> Attached
9. CEC 106, IT Component Reporting Form			<input checked="" type="checkbox"/> Attached

 Contract Manager Date Office Manager Date Deputy Director Date

The following signatures are only required when contract approval is delegated to the Executive Office and not approved at a Business Meeting. See Business Meeting Information Section.

 Presiding Policy Committee Date Associate Policy Committee Date Executive Director Date

United States Department of Energy

Funds-In Agreement for Research and Development

Exhibit A - Statement of Work

Exhibit B - Budget

Exhibit C – General Terms & Conditions

Exhibit D – Special Terms & Conditions

Exhibit E - Confidential Deliverables and Intellectual Property Lists

Exhibit F - List of Contacts And Addresses

Exhibit G – Payments to Sponsor

Prepared by the Lawrence Berkeley National Laboratory
May 5, 2010 **(REVISED February 2, 2012)**

I. Title of project

Healthy Homes – Exposure to Unvented Combustion Gases

II. Energy Commission RFP identification

N/A

III. Background

The U.S. Department of Energy has directed University of California to perform the work stated in this Appendix A for the Energy Commission. Lawrence Berkeley National Laboratory, a laboratory owned by the U.S. Department of Energy (U.S. DOE), is located at 1 Cyclotron Road, Berkeley, CA 94720. The University of California, a not-for-profit corporation organized under the laws of the State of California, with its principal place of business at 1111 Franklin Street, Oakland, CA 94607-5200, manages and operates Lawrence Berkeley National Laboratory under U.S. DOE Contract No. DE-AC02-05CH11231.

The California Energy Commission (Energy Commission) is an agency organized under the laws of the State of California with a principal place of business at 1516 Ninth Street, Sacramento, California 95814.

IV. Project Goals and Objectives

Problem Statement

Unvented and improperly vented combustion sources in residences can lead to high indoor pollutant concentrations and exposures, presenting a substantial health hazard. It is well established that combustion-related pollutants reach hazardous levels in homes, yet there is a dearth of data that would allow an assessment of the frequency of such occurrences. There is also a need to understand the relative importance of factors thought to impact indoor concentrations of combustion-generated pollutants. This research aims to advance knowledge of these factors to

help prioritize and guide population exposure reduction efforts.

Combustion sources known to impact residential indoor air quality include motor vehicles in attached garages, unvented appliances including cooking and space heating devices, improperly functioning and/or improperly vented appliances including furnaces with cracked heat exchangers, temporarily back-drafting gravity vent water heaters and furnaces, improperly venting or back-drafting fireplaces, and miscellaneous sources such as candles, incense and cigarettes. This research will focus primarily on unvented, improperly vented and improperly functioning appliances.

Combustion appliances can emit several pollutants at rates that lead to unhealthy indoor levels. Carbon monoxide (CO) is the most acutely dangerous pollutant as evidenced by the persistence of fatalities and hospitalizations attributed each year to CO poisoning. Calls to emergency services for CO alarms provide additional evidence of hazard. Recent epidemiological and other studies that have included measurement of indoor concentrations have established that hazardous levels of nitrogen dioxide can result from use of unvented gas fireplaces or cooking appliances. Measured emission factors from a sample of natural gas ranges suggest that for a substantial fraction of these appliances heavy use can produce enough formaldehyde to substantially increase cancer risks and the frequency of exceeding shorter term guideline levels.

The broad goal of this project is to advance understanding of the factors that contribute to indoor air pollutant exposures from unvented and improperly vented combustion appliances for the purpose of reducing health risks to the population of California. A secondary goal is to examine the effect of gas quality on pollutant emissions from advanced technology residential water heaters.

V. Technical and economic/cost performance objectives

- A. The overall technical goals of this project are to develop the science for reducing health risks from indoor air pollutant exposures from unvented and improperly vented combustion appliances, and to **conduct targeted research to enable synergistic improvements in both energy efficiency and indoor air quality in California homes with gas appliances.**

The specific, technical objectives upon which this project's success will be evaluated are:

- develop approaches to quantifying exposures to unvented combustion gases and to identify key sources;
- quantify combustion-associated pollutant levels in a large number of occupied California homes under normal operation;
- investigate and quantify the relative importance of factors that contribute most substantially to exposures of unvented combustion gases;
- document the developed approaches and results in a technical publications.

- B. The overall economic/cost goal of this project is to:
- an economic/cost goal is not applicable to this project

The specific, economic/cost objectives upon which project's success will be evaluated are:

- economic/cost objectives are not applicable to this project

VI. Preliminary Activities

1.1 Attend Kick Off Meeting

The Facility Operator's Project Manager (Principal Investigator) shall attend a "kick off" meeting with the Energy Commission Contract Manager to review the Energy Commission's expectations for: accomplishing tasks described in the work statement; administrative requirements in the terms and conditions of the contract (e.g., invoicing, statements vesting title, prior approvals, data disclosure limitations, monthly progress reporting format and content, etc.); and the Energy Commission's roles and responsibilities. The location of this meeting shall be designated by the Energy Commission Contract Manager.

1.2 Describe Synergistic Projects

The Indoor Environment Department has several ongoing research activities that are synergistically related to this project. The most relevant currently funded activity is described below.

The U.S. DOE is supporting the Energy Performance of Buildings group to develop methods and protocols to investigate ventilation and indoor air quality in new homes across the US. As part of this project Lawrence Berkeley National Laboratory (LBNL) will be examining the performance of an inexpensive time-resolved CO monitor, the use of inexpensive temperature and humidity sensors to detect cooking activities, and the robustness of sensors to detect kitchen exhaust fan operation. The U.S. DOE project is additionally supporting some validation experiments for passive formaldehyde samplers. These activities will aid in selecting sensors and samplers, and setting sampling protocols for the Healthy Homes study.

1.3 Identify Required Permits

Prepare and submit to the Energy Commission Contract Manager a list of all permits required for construction and/or operation of equipment or the project facility, the name, address and telephone number of the permitting jurisdictions or lead agencies, and the schedule the Facility Operator will follow in applying for and obtaining these permits.

LBNL will not be required to obtain any permits for this project.

1.4 Obtain Required Permits

Facility Operator will supply written certification that Facility Operator has received all necessary and required permits to construct, operate, or test the proposed equipment or facility as soon as they are received. During this project, the Facility Operator shall comply with all applicable laws, ordinances, regulations and standards. If the Facility Operator is required to obtain permits specifically for performance of this Agreement, such permit expenses shall be separately identified as a cost and shall be reimbursable by the Energy Commission.

1.5 Prepare Production Readiness Plan

N/A

VII. Description of tasks to be performed

TECHNICAL TASKS

GLOSSARY

Specific terms and acronyms used throughout this work statement are defined as follows:

CPR	Critical Project Review
CO	Carbon Monoxide
Energy Commission	California Energy Commission
HSC	Human Subjects Committee
IEQ	Indoor Environmental Quality
ITAC	Interchangeability Technical Advisory Committee
LBNL	Lawrence Berkeley National Laboratory
NO ₂	Nitrogen Dioxide
NO _x	Nitrogen Oxides
<u>PRE</u>	<u>Pollutant Removal Effectiveness</u>
PIER	Public Interest Energy Research
TAC	Technical Advisory Committee
U.S. DOE	U.S. Department of Energy

SCOPE OF WORK

This agreement includes a set of administrative tasks and a set of Technical Tasks. The remainder of this work statement defines these Technical Tasks. Task descriptions include goals, Contractor activities, and deliverables. The deliverables, such as test plans, technical reports and other interim deliverables, for each task are defined to the extent possible, but are subject to change based on recommendations from the Project Manager and the approval of the Energy Commission Contract Manager. The Contractor shall submit a draft of each deliverable, unless described differently in the Technical Tasks, to the Energy Commission Contract Manager for review and comment in accordance with the approved Schedule of Deliverables. Deliverables not requiring a draft version are indicated by marking "(no draft)" after the deliverable name.

The Energy Commission Contract Manager will provide written comments back to the Contractor on the draft deliverable within 10 working days of receipt. Once agreement has been reached on the draft, the Contractor shall submit the final deliverable to the Energy Commission Contract Manager. The Energy Commission Contract Manager shall provide written approval of the final deliverable within 5 working days of receipt. Key elements from this deliverable shall be included in the Final Report for this project.

When creating technical deliverables, the Facility Operator shall use and follow, unless otherwise instructed in writing by the Commission Contract Manager, the latest version of the PIER Style Manual published on the Energy Commission's web site:

<http://www.energy.ca.gov/contracts/pier/contractors/index.html>

Technical Task List

Task 2.1	Protocols and Pilot Exposure Study
Task 2.2	Exposure Study and Analysis
Task 2.3	Advanced Water Heater Emissions
<u>Task 2.4</u>	<u>Transient Pollutant Concentrations from Cooking Burners</u>
<u>Task 2.5</u>	<u>Residential Range Hood Performance</u>
<u>Task 2.6</u>	<u>Research Support for Combustion Safety Diagnostic Development</u>

Task 2.1 Protocols and Pilot Exposure Study

The goals of this task are to develop protocols to quantify combustion-related pollutant concentrations in homes, conduct a pilot implementation of protocols and to obtain information about factors that impact these concentrations in occupied

homes.

The intent of this project is to advance understanding of indoor pollutant exposures resulting from use of unvented or improperly vented combustion appliances. This task will focus on the development and pilot implementation of protocols to measure pollutant concentrations and obtain other information about factors that impact concentrations of these pollutants in occupied California homes. The contractor will prepare a Program Study Plan that includes an Exposure Study Plan, a participant questionnaire and a Participant Recruitment Plan.

The preliminary plan is to collect data in homes using two approaches: (1) via mail-out of a basic sampling package for a large number of homes and (2) via research team visits to deploy and collect an enhanced package of samplers at a smaller number of homes. The basic package will include passive samplers to determine time-integrated concentrations of CO, nitrogen dioxide (NO₂) and potentially other pollutants. The enhanced package will include all basic package samplers with the following additional devices and measurement objectives under consideration: accurate and monitoring and logging of time-resolved CO using a research grade electrochemical sensing device, monitoring of appliance usage, and monitoring of kitchen and potentially other exhaust fan usage. In the pilot phase of the study, field research visits will be limited to localities that can be reached within a few hours' drive of LBNL. The mail-out survey will be open to homes throughout the state.

A questionnaire will be used to complement both basic and enhanced monitoring packages to obtain information about combustion appliance characteristics and use patterns along with building and household characteristics that will allow study results to be extrapolated beyond the study sample. Ultimately this information will allow a broader assessment of the hazard and prioritization of next steps to further quantify and/or mitigate pollutant exposures from combustion exhaust gases in California.

The pilot exposure study budget was developed with the intent to collect data at a minimum of 100 homes through a mail-out approach and at 20 homes via research team visits.

It is expected that the Exposure Study Plan will focus on CO and NO₂ as the primary pollutants of interest; these will be measured in all homes using passive sampling techniques that accurately quantify time-integrated concentrations. The use of inexpensive time-resolved, data-logging CO sensors will be investigated as a means to identify concentration peaks in some or all study homes. Nitrogen oxides (NO_x) – which can be measured using one of the commercially available methods for NO_x – is of interest both as a potential source of secondary air pollutants and as an indicator of overall combustion exhaust levels in homes. The preliminary plan is to quantify time-integrated nitrogen oxides concentrations in all study homes. Formaldehyde emissions by gas appliances can constitute a substantial fraction of total indoor emissions especially with frequent use of unvented cooking burners; the

initial intent would be to collect aldehyde samples in at least a subset of homes.

The contractor will draft a Participant Recruitment Plan will consist of two parts. One part will focus on the characteristics of the homes to include in the survey (selection). The second part will lay out the approach to identify and gain access to those homes. This will include identifying organizations that can help make contact with the residents (participant recruitment).

The preliminary plan for participant recruitment and selection is to focus on appliance, home and household characteristics that are hypothesized to have the greatest impact on exposures to unvented or improperly vented combustion gases. The minimum criterion for study inclusion is likely to be presence of at least one unvented combustion appliance (typically cooking device) and at least one other appliance that could emit pollutants into the occupied space through improper venting or back-drafting conditions (e.g. gravity vent central furnace or water heater). Preliminary characteristics targeted for over-sampling include those known or thought to increase the likelihood of elevated combustion appliance-related pollutant levels; these include: presence of wall or floor furnace; low-cost rentals and low-income or senior-owned homes which tend to have lower-cost, older and potentially less well-maintained appliances; new homes with low air infiltration rates that can lead to build-up of any emitted combustion gases; and frequent cooking with unvented appliance. The sample may include some homes without combustion appliances as controls.

The preliminary plan for participant recruitment is to use a multi-media, multi-pathway approach to capture the characteristics that will be targeted. The plan is to work through community groups (e.g. including renters' associations, low-income and senior support groups, asthma and other public health organizations, etc.) and other institutions that serve or have contact with Californians who fit the study criteria. As over-sampling will be targeted at homes thought to have a greater likelihood of high pollutant levels, we anticipate interest and support from these groups. We will use web-based, e-mail, telephone and traditional mail avenues to receive inquiries and expressions of potential interest. The recruitment plan will attempt to reach underserved communities and to ensure widespread access to all interested Californians. The recruitment plan must be approved by the LBNL Human Subjects Committee.

The Contractor shall:

- In consultation with the Energy Commission Contract Manager, establish a Technical Advisory Committee (TAC) for combustion-related pollutant exposure study
- Develop a list of members that have agreed to serve on the TAC
- Develop and present to the TAC an outline of key elements of the Program Study Plan including the Exposure Study Plan and the Participant Recruitment Plan and prepare meeting notes
- Develop a Program Study Plan that incorporates TAC comments and includes:

- An Exposure Study Plan that includes protocols for measuring combustion-related pollutant concentrations (including CO, NO₂ and aldehydes) and – when feasible – other parameters to provide information about factors that impact combustion-related pollutant levels in occupied homes
- A questionnaire to obtain information about factors that impact combustion-related pollutant levels in occupied homes
- A Participant Recruitment Plan that targets over-sampling of homes with characteristics hypothesized to contribute most substantially to combustion-related pollutant exposures
- Submit the Program Study Plan to LBNL’s Human Subjects Committee (HSC) and obtain their approval
- Obtain written approval from the Energy Commission Contract Manager on the HSC-approved Program Study Plan
- Prepare all materials required for pilot study per the approved Exposure Study Plan portion of the Program Study Plan. This will include procurement of air quality measurement devices, and passive sampling media; calibration of passive carbon monoxide sensors; and preparation of laboratory methods for passive sampler analysis
- Construct and post a project web site to be used for recruitment and communication with participants, and for purposes of educating the public about the study
- Implement the Participant Recruitment Plan portion on the Program Study Plan; work with community groups and other institutions to recruit participants for the pilot study
- Design and construct a database for data compilation and storage; design the database with consideration of data analysis in Task 2.2
- Implement a pilot study per the approved Program Study Plan, including all required chemical analyses and processing of information about contributing factors
- Analyze data from the pilot study and questionnaire and summarize results in a Pilot Exposure Study Memorandum
- Meet with the TAC to report on results of pilot exposure study and prepare meeting notes
- Summarize pilot exposure study results for a general audience and post on the website

Deliverables:

- List of TAC members
- Notes from TAC meetings
- HSC approved Program Study Plan
- Project Web Site
- Pilot Exposure Study Memorandum

Task 2.2 Exposure Study and Analysis

The goals of this task are to measure combustion-related pollutant concentrations and to obtain information about factors that impact these concentrations in occupied homes in California, to analyze these data to advance understanding of the hazards of such exposures and priorities for mitigation, and to report the findings of these investigations.

The specific implementation of this task will be shaped by the results and lessons learned from Pilot Exposure Study and Participant Recruitment Plan. Work on this task will begin with a review of the Task 2.1, Pilot Exposure Study. The costs, challenges and results obtained from each of the two data collection approaches will be presented to the TAC. Changes deemed to be essential or highly beneficial will be presented to the Human Subjects Committee for potential revision of the approved study plan.

The preliminary exposure plan is to continue with a two-tiered approach to data collection, including mail-out of basic sampling packages and research team visits to deploy enhanced sampling packages. Considerations of cost and operational necessities may continue to limit research team visits to localities within a few hours' drive of LBNL. The preliminary plan is to aggressively target recruitment for the mail-out sampler to identify participating households throughout the state. As with the pilot exposure study, the anticipated focus will be on capturing key appliance, building and household characteristics rather than attempting to recruit a statistically representative sample.

The Task 2.2 budget was developed with the intent to collect data at least 100 homes through a mail-out approach and at least 20 homes via research team visits. The final sample size will depend on the breakdown of these two approaches to data collection, costs and the success of recruitment efforts.

Data analysis will focus on relating the measured pollutant concentrations to key appliance, home and household characteristics. The objective will be to identify and quantify the relative importance of the factors that impact combustion-related pollutant concentrations. Results will be extrapolated using information about the California population of appliances, homes and households, e.g. from the Residential Appliance Saturation Survey and other population-based data sources.

Results from the study will be documented in a technical paper that will be submitted for publication in a peer-reviewed archival journal. Results will also be translated for public dissemination. Results will be posted on the project web site, shared with the participating community groups, and communicated directly to study participants as appropriate.

The Contractor shall:

- Based on the pilot study, present proposed changes to the Program Study Plan to the TAC and prepare meeting notes
- Update the Program Study Plan in consideration of results and operational lessons learned from the pilot study and TAC comments, as appropriate
- If required due to significant changes, submit the updated Program Study Plan to the LBNL HSC and obtain their approval
- Obtain written approval from the Energy Commission Contract Manager on the updated Program Study Plan
- Update the project web site to reflect the updated study plan and recruitment targets
- Prepare additional sampler packages consistent with the updated Exposure Study portion of the Program Study Plan
- Work with community groups and other institutions per the Participant Recruitment portion of the Program Study Plan to recruit exposure study participants
- Implement exposure study data collection per the Exposure Study portion of the Program Study Plan including all required chemical analysis and the questionnaire
- Compile and enter all collected data into a database
- Analyze the collected data
- Document study methods and results in a technical report
- Meet with the TAC, report study results and prepare meeting notes
- Incorporate TAC comments into the technical report as appropriate
- Document summary study methods and results in a technical paper and submit to a peer-reviewed archival journal
- Summarize study results for a general audience and post on the website

Deliverables:

- Notes from TAC meetings
- Updated HSC approved Program Study Plan (if required)
- Updated Program Study Plan
- Updated project Web Site
- Exposure Study and Analysis Technical report (no draft)
- Submitted Technical journal paper

Task 2.3 Advanced Water Heater Emissions

The goals of this task are to measure baseline pollutant emission factors and the effect of fuel Wobbe number on emission factors of advanced technology residential water heaters.

This task will use methods developed by LBNL in a previous assessment of residential appliance interchangeability as part of CEC Contract 500-05-026. The protocol involves installation of the appliance in the laboratory in a manner that is consistent with field installation, followed by operation over a specific activity pattern

with fuels having varying properties and characteristics. The baseline fuel will be line gas delivered to LBNL. Higher-Wobbe fuel(s) will be supplied via pre-mixed cylinders. The protocol involves operation to provide water at 1, 2 and 4 gallons per minute. Experiments will quantify emission factors for carbon monoxide, nitrogen oxides, nitrogen dioxide and formaldehyde.

This task will focus on advanced technology and recent model waters that were not tested in the previous study or that were tested in small numbers and found to have a substantial sensitivity to increasing fuel Wobbe number. Specific technologies and potentially specific makes and models to be targeted will be determined in consultation with a Interchangeability Technical Advisory Committee (ITAC). The TAC will be composed of experts on appliance technologies potentially including industry representatives. The preliminary plan is that most of the appliances to be evaluated will be procured new from retail vendors. A small number of prototype technologies may be included (with manufacturer anonymity assumed to be a reasonable condition), as long as all results can be included in public reports of this work.

The intent is to evaluate 12-14 units on baseline and two higher-Wobbe fuels.

The Contractor shall:

- In consultation with the Energy Commission Contract Manager, establish an Interchangeability Technical Advisory Committee (ITAC) for an advanced water heater emissions study
- Develop a list of members that have agreed to serve on the ITAC
- Work with the ITAC to develop a prioritized list of technologies and potentially specific makes and models of advanced water heaters to evaluate; targeted appliances will include tankless and ultra-low NO_x storage water heaters
- Procure, install, and conduct experiments using test procedures developed in Energy Commission Contract 500-05-026 to quantify baseline emission factors and assess sensitivity of emission factors for CO, NO_x, NO₂ and formaldehyde to increasing fuel Wobbe number for at least 12 advanced residential water heaters; test a minimum of two fuel mixtures
- Analyze data
- Prepare a draft Technical Report summarizing methods and results of advanced water heater emissions evaluation experiments
- Prepare final technical report incorporating Energy Commission and TAC comments as appropriate

Deliverables:

- List of ITAC members
- List of technologies
- Advanced Water Heater Emissions Technical Report

Task 2.4. Transient Pollutant Concentrations from Cooking Burners

The objectives of this task are to: (1) conduct measurements to improve understanding of time-resolved pollutant concentrations and acute pollutant exposures in homes that use natural gas cooking burners on a daily basis; and (2) conduct a pilot evaluation of the benefits of using existing venting range hoods.

The Contractor shall:

- **Develop a Monitoring Field Study Plan for measurement of time-resolved pollutant concentrations and acute pollutant exposures in homes that use natural gas cooking burners on a daily basis. This plan will include:**
 - **Measurement of the following performance parameters for each study home:**
 - **Cooking exhaust fan airflow rate and capture efficiency at each fan setting**
 - **Depressurization to assess whether use of the kitchen exhaust fan may cause backdrafting and spillage of any natural draft gas appliances present in the home**
 - **Monitoring of the following parameters throughout the study period in each home:**
 - **Time-resolved indoor concentrations of NO_x, NO₂, CO and CO₂**
 - **Time- and size-resolved indoor and outdoor particle number concentrations**
 - **Air exchange rate**
 - **Burner and exhaust fan use**
 - **Cooking activities (type of cooking)**
- **Obtain CCM approval of the Monitoring Field Study Plan before conducting the field study.**
- **Develop a Participant Requirement and Recruitment Plan in consultation with the Commission Contract Manager, TAC, and LBNL Human Subjects Committee.**
- **Obtain approval of the Participant Requirement and Recruitment Plan from the LBNL Human Subjects Committee.**
- **Design and construct a sampling system suitable for deployment in study homes for the required period of study (at least 6 days).**
- **Develop protocols for instrument calibration and deployment.**
- **Design and construct a database to manage data.**
- **Conduct recruitment and sampling in at least 10 study homes per the Monitoring Field Study Plan, Participant Requirement and Recruitment Plan, and deployment protocols.**
- **Review data for quality assurance and prepare a consolidated data set.**
- **Analyze data to quantify exposures resulting from burner use without exhaust ventilation and the benefit of using exhaust ventilation when using cooking burners.**

- Present the monitoring and analysis results to the TAC using a slide presentation or other written format as appropriate.
- Prepare a Technical Manuscript that presents results of Task 2.4 and submit the manuscript to a peer-reviewed archival journal.
- Ensure that the Technical Manuscript is available to the general public through LBNL online reports database.

Deliverables:

- Monitoring Field Study Plan
- Participant Requirement and Recruitment Plan
- Protocols for instrument deployment and calibration
- Copy of presentation slides presented to TAC (final)
- Technical Manuscript

Task 2.5. Residential Range Hood Performance

The objective of this task is to conduct research to support the establishment of an industry-standard test method for pollutant removal effectiveness (PRE) of residential range hoods. A standard test for PRE will enable the specification of minimum exhaust hood performance requirements in residential ventilation and energy efficiency standards. This task will support the technical aspects of method development and demonstration, with focus on the needs and opportunities of California regulations and standards including Title 24.

Establishing a standard method of test is a stakeholder-driven process that is administered through the American Society of Testing and Materials (ASTM). The U.S. Department of Energy (DOE) is providing FY12 support to LBNL to initiate this stakeholder process.

The Contractor shall:

- Develop a Range Hood Test Plan including a draft “Test Protocol for Removal Effectiveness of Pollutants Produced by Combustion and Cooking” that will assess the effectiveness of range hoods for removing pollutants generated by combustion and cooking.
- Present the test plan to the TAC and incorporate any comments from the TAC as appropriate.
- Obtain CCM approval of the Range Hood Test Plan before implementing the plan.
- Design and construct an experimental apparatus suitable for measuring range hood pollutant removal effectiveness for combustion and cooking.
- Conduct tests as required by the Range Hood Test Plan. Apply draft protocol to evaluate combustion and cooking pollutant PRE for at least 5 common range hood designs and at least 3 cooking activities.
- Revise the Test Protocol for removal effectiveness of pollutants produced by combustion and cooking

- Present test results and the Test Protocol to the TAC using a slide presentation or other written format as appropriate.
- Present test results and test protocol to the ASTM committee charged with developing a standard test method using a slide presentation or other written format as appropriate.
- Prepare a Technical Manuscript that presents results of Task 2.5 and submit to a peer-reviewed archival journal.
- Ensure that the Technical Manuscript is available to the general public through LBNL online reports database.

Deliverables:

- Range Hood Test Plan
- Copy of presentation slides presented to TAC (final)
- Copy of presentation slides presented to ASTM committee (final)
- Test Protocol for Removal Effectiveness of Pollutants Produced by Combustion and Cooking
- Technical Manuscript

Task 2.6. Research Support for Combustion Safety Diagnostic Development

The objective of this task is to conduct research to improve understanding of backdrafting and spillage of combustion products from natural gas appliances in California homes that have been or will be retrofitted for air-tightness. This information will support development of a more robust and consistent diagnostic protocol to enable maximum air sealing for energy efficiency without creating spillage-related indoor air quality hazards. Development of the diagnostic protocol is being funded primarily through a PIER Buildings project.

The majority of effort for this task will focus on monitoring to determine the frequency of backdrafting and spillage in homes having risk factors for improper venting of natural draft appliances. Highest priority will be given to monitoring in homes that have already been identified as at-risk for spillage, ideally focusing on homes for which air-sealing has been limited due to concerns about appliance venting.

The Contractor shall:

- Develop a Backdrafting and Spillage Test Plan to collect information about the characteristics of California homes with natural gas appliances that are or would be at risk of exhaust gas spillage when envelopes are optimally air-sealed to improve energy efficiency and comfort. This plan will address collection of data on residences to understand critical questions on the building characteristics and operations of homes that can result in backdrafting and spillage and the prevalence of these phenomena.
- Obtain CCM approval of the Backdrafting and Spillage Test Plan before conducting the rest of this task.

- Establish collaborations with administrators and contractors working on low-income weatherization and energy efficiency retrofit programs. The purpose of this collaboration will be to obtain information about homes receiving sub-optimal air sealing because of appliance venting concerns and/or to use these networks to recruit participants for the monitoring study.
- In consultation with the TAC and CCM, develop a Draft Recruitment and Monitoring Plan.
- Obtain approval of the Final Draft Recruitment and Monitoring Plan from LBNL's Human Subjects Committee. Submit the plan that has been approved by the Human Subjects Committee.
- Design an equipment package as required by the test plan that can be installed in residences to monitor and record parameters needed to identify sustained backdrafting and spillage events over a period of at least one month.
- Implement the backdrafting and spillage test and recruitment and monitoring plans to collect data in at least 50 California homes.
- Compile monitoring data from homes into a database suitable for statistical analysis.
- Review data for quality assurance.
- Analyze data to determine the frequency of backdrafting and spillage events in at-risk homes and to discern the relative importance of various contributing factors.
- Present results of this task to the TAC using a slide presentation or other written format as appropriate.
- Prepare a Technical Manuscript that presents results of Task 2.6 and submit to a peer-reviewed archival journal.
- Ensure that Technical Manuscript is available to the general public through an LBNL online reports database.

Deliverables:

- Backdrafting and Spillage Test Plan
- Recruitment and Monitoring Plan(final)
- Copy of presentation slides presented to TAC (final)
- Technical Manuscript

Task 3.0 Reporting Tasks

All reports shall be delivered to:

Accounting Office, MS-2
 California Energy Commission
 1516 9th Street, 1st Floor
 Sacramento, CA 95814

Task 3.1 Quarterly Progress Reports

The Contractor shall prepare written Quarterly Progress Reports to the Energy Commission Contract Manager by the 30th of the following month, starting after the Department of General Service's contract approval date and continuing each month until the Final Report has been accepted by the Commission Contract Manager. Attachment A-1 provides a recommended format and content requirements for the Monthly Progress Report.

Deliverables:

- Quarterly Progress Reports

Task 3.2 Final Report

The Final Report shall be a public document. If the Contractor will be preparing a confidential version of the final report as well, the Contractor shall perform the following tasks for both the public and confidential versions of the Final Report. When creating the Final Report, the Facility Operator shall use and follow, unless otherwise instructed in writing by the Energy Commission Contract Manager, the latest version of the PIER Style Manual published on the Energy Commission's web site:

<http://www.energy.ca.gov/contracts/pier/contractors/index.html>

Subtask 3.2.1 Final Report Outline

- Contractor shall prepare and submit to the Energy Commission Contract Manager for review an outline of the Final Report describing the original purpose, approach and results of the project.
- The outline shall be submitted to the Energy Commission Contract Manager for review. The Energy Commission Contract Manager shall determine if the outline is satisfactory. If the Energy Commission Contract Manager determines that the outline is unsatisfactory, he or she will, in a timely manner, provide to the Contractor written comments, which indicate how the outline can be improved. The Contractor shall revise the outline to meet the Energy Commission Contract Manager's requirements. Upon finding the final report outline satisfactory, the Commission Contract Manager shall provide to the Contractor written approval of it.

Deliverables:

- Outline of the Final Report

Subtask 3.2.2 Draft Final Report for Comment

- The Contractor shall prepare and submit to the Energy Commission Contract Manager a draft Final Report on the project. The format of the report shall follow the approved outline.
- The draft final report shall be submitted to the Energy Commission Contract Manager for review and to determine, in a timely manner, if it is satisfactory. If the Energy Commission Contract Manager determines that it is unsatisfactory, he or she will, provide to the Contractor written comments, which indicate how it can be improved. The Contractor shall revise the draft final report incorporating the Energy Commission Contract Manager's corrections and required changes. Upon finding the revised draft to be satisfactory, the Commission Contract Manager shall provide to the Contractor written approval of it.

Deliverables:

- Draft Final Report

Subtask 3.2.3 Final Report

- The Contractor shall prepare Final Report and submit it to the Energy Commission Contract Manager after receiving the Energy Commission Contract Manager's written approval of the draft Final Report. This task shall be deemed complete and accepted by the Commission only when the Energy Commission Contract Manager approves the Final Report in writing. Upon approval, the Contractor shall submit two unbound copies of the Final Report to the Energy Commission Contract Manager.

Deliverables:

- Final Report

Task 3.3 Final Meeting

Contractor shall meet with the Energy Commission Contract Manager to present findings, conclusions, and recommended next steps (if any) for the project.

Contractor will also discuss with the Energy Commission Contract Manager the following contract close-out items:

- What to do with any state-owned equipment (Options), if applicable
- Commission's request for specific "generated" data (not already provided in contract deliverables)
- Need to document Contractor's disclosure of "subject inventions" developed under the contract

- Need to file UCC-1 form re: Commission's interest in patented technology
- Other "surviving" contracts provisions.

VIII. Critical Project Reviews

The Energy Commission will conduct critical project reviews at the conclusion of the following tasks:

IX. Sponsor's Key personnel and Agreement Management

- A. The name and area code/phone number of the California Energy Commission's Contract Manager is listed on Exhibit F and is the official technical contact for the Energy Commission.

The Sponsor's Contract Manager is responsible for the day to day project status, decisions and communications with the Facility Operator Project Manager (Principal Investigator). The Commission Contract Manager will review and approve all project deliverables, reports, and invoices.

The Sponsor may change the Contract Manager by notice given to the Facility Operator at any time signed by the Contract Officer of the Energy Commission.

- B. The name and area code/phone number of the California Energy Commission's Contract Officer is listed on Exhibit F and will be the Contract Officer for the Agreement and is the official administrative contact for the Energy Commission.

X. Facility Operator's Key Personnel and Agreement Administration

The Facility Operator is obligated to comply with the terms and conditions of its Management and Operating (M&O) Contract with the DOE when performing work under this agreement. The DOE may require substitution of the named "key personnel" under this agreement should the DOE determine that the services of the Project Manager (Principal Investigator) or other named key personnel are necessary to meet the Facility Operator's M&O Contract obligations to the DOE. Should the DOE direct the Facility Operator to substitute the named key personnel under this agreement, the Facility Operator shall inform the Energy Commission of the directed substitution in accordance with paragraphs A and B below. In the event that the Energy Commission does not concur with the substitution of named key personnel as directed by the DOE, this agreement shall be terminated under Article XX, Termination, of the modified terms and conditions.

- A. The name and area code/phone number of the National Laboratory's Project

Manager (Principal Investigator) is on Exhibit D and will be the Project Manager (Principal Investigator) for this project and is the official technical contact for Lawrence Berkeley National Laboratory.

The Facility Operator's Project Manager (Principal Investigator) is responsible for the day to day project status, decisions, and communications with the Sponsor's Contract Manager. The Facility Operator's Project Manager (Principal Investigator) will review and approve all project deliverables and reports.

The Facility Operator's Project Manager (Principal Investigator) is designated as "key personnel" under the Agreement. The Energy Commission reserves the right to prior written concurrence of any substitution of the Project Manager (Principal Investigator).

- B. The key personnel are listed on Exhibit F in this agreement.

Facility Operator's key personnel may not be substituted without the Commission Contract Manager's prior written concurrence. Such concurrence shall not be unreasonably withheld. All other personnel may be substituted by Facility Operator, with written notification made to the Commission Contract Manager.

- C. The name and area code/phone number of National Laboratory Agreement Administrator is on Exhibit F and will be the Agreement Administrator for this Agreement and is the official administrative contact for Lawrence Berkeley National Laboratory.

XI. Facility Operator's key subcontractors

The Facility Operator's key subcontractors are listed on Exhibit F in this agreement.

Facility Operator's key subcontractors may not be substituted without the Commission Contract Manager's prior written concurrence. Such concurrence shall be timely provided and not unreasonably withheld. Delay in written concurrence may result in a work stoppage of subcontract work. All other subcontractors may be substituted by Facility Operator, with written notification made to the Commission Contract Manager.

XII. Report standards

- A. The report outline and format will be provided by the Sponsor's Contract Manager to the Facility Operator's Project Manager (Principal Investigator).
- B. All reports shall be delivered to the Accounting address shown on Exhibit F.

- C. Progress Reports. The Facility Operator shall prepare a Progress Report that summarizes all Agreement activities conducted by the Facility Operator to date, with an assessment of ability to complete the project within the current budget and any anticipated cost overruns. Each Progress Report is due to the Commission Contract Manager within 30 days after the end of the reporting period. The Commission Contract Manager will specify the report format and contents and the number of copies to be submitted.

- D. Final Report and Final Meeting. At the conclusion of the Agreement's technical work as provided for this Appendix A Statement and revised project plan, Facility Operator shall prepare a comprehensive written Final Report, including an Executive Summary. The Commission Contract Manager will review and approve the Final Report.

XIII. Schedule

The program will continue for 58 months after advance funding is received by the University of California. This Agreement is effective the later date of (1) the date on which it is signed by the last of the parties thereto, or (2) the date on which it is approved by the California Department of General Services as noted on the Standard Agreement, or (3) the date on which the Facility Operator receives advance funding from the Sponsor.

XIV. Budget

Exhibit B shows Energy Commission's Reimbursable Budget.

Exhibit B shows the assessed value of the Federal Administrative Charge not charged to this project.

SOW Exhibit A shows assessed value of synergistic projects. The assessed value of such synergistic projects does not constitute a funding contribution or obligation (either cash or in-kind) on the part of the DOE or the Facility Operator.