State of California
AIR RESOURCES BOARD

RESEARCH PROPOSAL

Resolution 06-12

April 20, 2006

Agenda Item No.: 06-4-2

WHEREAS, the Air Resources Board has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2608-251, entitled "Indoor Environmental Quality and HVAC Survey of Small and Medium Size Commercial Buildings", has been submitted by the University of California, Berkeley;

WHEREAS, the Research Division staff has reviewed and recommended this proposal for approval; and

WHEREAS, the Research Screening Committee has reviewed and recommends for funding:

> Proposal Number 2608-251 entitled "Indoor Environmental Quality and HVAC Survey of Small and Medium Size Commercial Buildings", submitted by the University of California, Berkeley, for a total amount not to exceed $559,966.

NOW, THEREFORE BE IT RESOLVED, that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendation of the Research Screening Committee and approves the following:

> Proposal Number 2608-251 entitled "Indoor Environmental Quality and HVAC Survey of Small and Medium Size Commercial Buildings", submitted by the University of California, Berkeley, for a total amount not to exceed $559,966.

BE IT FURTHER RESOLVED, that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the research effort proposed herein, and as described in Attachment A, in an amount not to exceed $559,966.

I hereby certify that the above is a true and correct copy of Resolution 06-12, as adopted by the Air Resources Board.

Lori Andreoni

Lori Andreoni, Clerk of the Board

## ATTACHMENT A

## "Indoor Environmental Quality and HVAC Survey of Small and Medium Size Commercial Buildings"

### Background

California Energy Commission's (CEC) research into Small Commercial Buildings (SMCB) energy efficiency standards have addressed demand control ventilation, schools, fast food restaurants, and a few other types of businesses. However, no systematic review of prevailing HVAC practices in the SMCB sector and the resulting indoor air quality has ever been attempted. The most ambitious survey of its kind for commercial businesses, the California End Use Survey (CEUS), working from the utility billing database, solicited data from thousands of California businesses. The survey included HVAC information such as single or multiple zones, code descriptions, chillers, square footage, number of single HVAC units, types of business, number of employees, and much more information of critical use to study SMCB in California. The CEUS information also includes data on HVAC controls such as energy management/control systems, optimal start-stop, chiller sequencing, static pressure retest on HVAC system demand, outside air intake controls ($CO_2$, VOC, or other sensors), night ventilation, and demand control ventilation (DCV). Subject to legal action much of the CEUS information has never been available for SMCB study.

The United States Environmental Protection Agency's Building Assessment Survey and Evaluation Study (BASE) of 100 buildings remains another source of data on SMCB. Analyses of the ventilation data have greatly improved our understandings of indoor air quality and HVAC practices. There were only fifteen California buildings and the sample size of SMCB remains too narrow of a database to build a statistically representative sample. The Department of Energy's Commercial Building Energy Consumption Survey (CBECS) is another resource for this work and includes information on space heating and cooling activities. A survey program is required to bring together the lessons learned from these other studies and to systematically address SMCB issues in California for the first time. Confidentiality protection given to previous study participants (e.g., CEUS, BASE, and CBECS) counsels against further solicitation for participation in this study using lists already developed by other studies. The lists from earlier studies are in fact unavailable to any other investigators. As the field portion of this study is of key importance to CEC staff, the survey program is critical to establishing a list of potential participants.

### Objective

The objective of this research project is to conduct a systematic review of SMCB HVAC practices and existing practices for indoor air quality. Specifically, the contractor will:

1) Develop statewide information on ventilation characteristics for the SMCB sector, including design and performance specifications for HVAC systems, air control systems, natural ventilation, and filtration systems
2) Develop statewide information on operation and maintenance patterns of HVAC systems in the SMCB sector such as commissioning, inspecting, testing, training of maintenance staff, cleaning practices, and repairing HVAC, filtration, and control systems

3) Develop statewide information on IAQ characteristics of SMCB, including occupant complaints, potential sources of indoor pollutants, and histories of moisture problems
4) Characterize remedial actions that have been taken in SMCB in response to IAQ complaints or moisture problems, or to prevent IAQ problems
5) Assess the correlation of SMCB building and/or equipment characteristics with the potential for poor ventilation and IAQ

Phase I survey work must also develop insights to guide the selection of facilities for inspection and to create a contact list of SMCB building owners/operators sufficient for properly conducting the field study program (Phase II). Phase II data on design and performance of HVAC and air filtration systems for buildings visited would be critical to developing Title 24 rule-making by circa 2011 (need to begin process in 2008). Naturally, Phase II preparations are of significant concern to Energy Commission staff.

**Methods**

With CEC, ARB, and Lawrence Berkeley National Laboratory (LBNL) assistance, Survey Research Center (UC Berkeley SRC) staff will develop the questionnaires and test them using at least two focus groups. The CEC, ARB, LBNL, and SRC staff will then test the questionnaires in a small pilot study. We will discuss these developments with the Expert Committee and seek their advice in proceeding to the full survey. When we have the consent of the Expert Committee, SRC staff will conduct the full scale survey. SRC staff will use a commercial database as a starting point.

**Expected Results**

The first representative survey database of SMCB sector in California will be available for analysis of pertinent indoor air quality issues. Contractor analyses will provide the outlines of existing practices for indoor air quality and HVAC for the SMCB sector. The Contractor will provide the necessary data to select participants for the field survey where actual HVAC and indoor air quality problems would be identified and comparisons between the field and the survey findings would make representative conclusions possible.

**Significance to the Board**

ARB ambient air quality standards and CEC indoor "thermal comfort" and "energy efficiency" building standards complement each other. Successful execution of this contract significantly expands the Board's assistance to the CEC building standards program and reinforces the historical role of ARB as the principal analytical state agency for indoor air quality.

**Contractor:**

University of California, Berkeley, Survey Research Center and Lawrence Berkeley National Laboratory

**Contract Period:**
27 months.

**Principal Investigator (PI):**
Thomas Piazza (UCB SRC), and Michael G. Apte (LBNL)

**Contract Amount:**
$559,966

**Basis for Indirect Cost Rate:**
The State and the UC system have agreed to a ten percent indirect cost rate.

**Past Experience with this Principal Investigator:**
The SRC have performed very well during the New Home Survey project and have contributed their research, their sample program, and their analytical support to the field portion of the New Home project. We are quite pleased with their service.

**Prior Research Division Funding to UCB:**

| Year | 2005 | 2004 | 2003 |
|---|---|---|---|
| Funding | $1,271,460 | $922,057* | $715,194 |

* Approximately $780,000 was funded by the California Energy Commission.

# BUDGET SUMMARY

University of California Berkeley, Survey Research Center

"Indoor Environmental Quality and HVAC Survey of Small and Medium Size Commercial Buildings"

| | | | |
|---|---|---|---|
| **DIRECT COSTS AND BENEFITS** | | | |
| 1. | Labor and Employee Fringe Benefits | $ 263,604 | |
| 2. | Subcontractors | $ 169,800 | |
| 3. | Equipment | $ 0 | |
| 4. | Travel and Subsistence | $ 4,380 | |
| 5. | Electronic Data Processing | $ 12,329 | |
| 6. | Reproduction/Publication | $ 2,300 | |
| 7. | Mail and Phone | $ 14,850 | |
| 8. | Supplies | $ 20,375 | |
| 9. | Analyses | $ 0 | |
| 10. | Miscellaneous | $ 37,664 | |
| | Total Direct Costs | | $525,302 |
| **INDIRECT COSTS** | | | |
| 1. | Overhead | $ 34,664 | |
| 2. | General and Administrative Expenses | $ 0 | |
| 3. | Other Indirect Costs | $ 0 | |
| 4. | Fee or Profit | $ 0 | |
| | Total Indirect Costs | | $34,664 |
| **TOTAL PROJECT COSTS** | | | **$559,966** |

**Attachment 1**

# SUBCONTRACTORS' BUDGET SUMMARY

Subcontractor: Lawrence Berkeley National Laboratory

Description of subcontractor's responsibility: Guide the Survey Program, Develop Survey Instruments, Support the Survey Program throughout Implementation, Analyze the Survey Data, Provide Conclusions about SMCB from Analyses.

| **DIRECT COSTS AND BENEFITS** | | | | |
|---|---|---|---|---|
| 1. | Labor and Employee Fringe Benefits | $ | 84,432 | |
| 2. | Subcontractors | $ | 0 | |
| 3. | Equipment | $ | 0 | |
| 4. | Travel and Subsistence | $ | 1,750 | |
| 5. | Electronic Data Processing | $ | 0 | |
| 6. | Reproduction/Publication | $ | 0 | |
| 7. | Mail and Phone | $ | 0 | |
| 8. | Supplies | $ | 3,620 | |
| 9. | Analyses | $ | 0 | |
| 10. | Miscellaneous | $ | 5,387 | |
| | Total Direct Costs | | | $95,189 |

| **INDIRECT COSTS** | | | | |
|---|---|---|---|---|
| 1. | Overhead | $ | 48,438 | |
| 2. | General and Administrative Expenses | $ | 0 | |
| 3. | Other Indirect Costs | $ | 26,173 | |
| 4. | Fee or Profit | $ | 0 | |
| | Total Indirect Costs | | | $74,611 |
| **TOTAL PROJECT COSTS** | | | | **$169,800** |