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UNIVERSITY OF CALIFORNIA, DAVIS

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718401

OFFICE OF THE DEAN
GRADUATE STUDIES AND
RESEARCH

DAVIS, CALIFORNIA 95616

DEC 1 1988

Office of Research
275 Mrak Hall
(916) 752-2075

8902 068

U.S. Department of Energy
Oak Ridge Operations Office
ATTN: Ms. Susan G. Hiser
Procurement and Contracts Division
Post Office Box 2001
Oak Ridge, Tennessee 37831-8758

Reference: Research Proposal Entitled **"Atmospheric Backscatter LIDAR System"**
Principal Investigator - **John J. Carroll**

Dear Ms. Hiser:

It is our pleasure to present for your consideration the referenced proposal for the **University Research Instrumentation Program Solicitation Number DE-PS01-88ER75461.**

Please call on the principal investigator for scientific information. Administrative questions may be directed to Louise Ivey at the above address and phone number. We request that correspondence pertaining to this proposal and a subsequent award be sent to the Office of Research and to the principal investigator.

Sincerely,

Marilyn Rush
Research Officer

MR/eb
Enclosure
cc: J.J. Carroll

REPOSITORY Oak Ridge Operations
COLLECTION Records Holding area
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2 of 3
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U.S. DEPARTMENT OF ENERGY
UNIVERSITY RESEARCH INSTRUMENTATION PROGRAM

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COVER PAGE
(THIS PAGE MUST BE THE FIRST PAGE OF THE APPLICATION)

1. Name of Institution: The Regents of the University of California
2. Address: City Davis 3. State CA 4. ZIP 95616
5. Principal Investigator: John J. Carroll
   (Note - The PI should preferably have an active DOE award in the designated research area)
6. Department: Land, Air and Water Resources/Laboratory for Energy Related Health Research
7. Telephone: Area Code 916 Office: 752-3245 Home: [redacted]
8. Title of Application: Atmospheric Backscatter LIDAR System.
9. Area of Proposed Research (Select ONE) A. Biomedical/Environ. *

   A. Biomedical/Environmental
   B. Combustion/Conversion/Coal Science Chemistry
   C. Energy Engineering
   D. Materials/Electro-opucal
   E. Nuclear Physics
   F. Other

10. Research Subcategory (See Section II of DOE/URI FY 88 Announcement) Environmental Process and Effects
11. Total DOE Funding for Research in Selected Area (During the last two fiscal years): $ 415,000
12. Estimated Purchase Price of Equipment: $ 402,000
13. Amount Requested from DOE: $ 400,000

List all Federal agencies which are currently considering proposals from the institution involving the same or similar equipment.

14. Agency: NONE Agency Proposal Number:
15. Agency: Agency Proposal Number:

NOTE: The institution is responsible for immediately informing the URI program manager in writing if a proposal involving similar or related equipment is submitted to a federal agency prior to the announcement of DOE's URI awards.

16. List any federal agency which has provided funds to the institution during the past two years for the same or similar equipment.

    Agency: NONE Amount of Funds:

17. Please check one of the following:

    [X] I authorize outside peer review of this proposal.

    [ ] I do not authorize outside peer review of this proposal.**

Signature of Principal Investigator: Date: November 30, 1988

Name of Title of Institutional Official
(President or Designee)
Alan G. Marr

Signature:
Date:

Dean of Research

* Note - The application will be evaluated by reviewers in this field.
** Note - May prevent full consideration of this application.

1127033

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112704

SUMMARY

This proposal is being submitted by six faculty from the University of California, Davis. We have a long collective history in energy related research. Our interests are primarily in the area of the environmental, biomedical, and public health repercussions of energy development and use. Current and past research of these faculty range from inhalation toxicology, through source control design and air pollution transport and diffusion modeling to monitoring particulate concentrations through out the arid western part of the United States. Separately, we are interested in the various problems associated combustion and other energy conversion technologies. Collectively we are studying the emission, diffusion, transport and fate air emissions and their biomedical and environmental implications. In much of our work, the emphasis is on airborne particles. Since particles are emitted directly by the majority of combustive sources and are formed by gas to particle conversion processes, they are good surrogate for total air quality evaluation as well as being important for the effects they themselves produce.

A major impediment to progress in each of our research areas is the inability to measure the temporal and spatial distribution of particles in a way that definitively describes the conditions and processes we are trying to study. With the application of remote sensing techniques, this impediment can be removed. One such device is an atmospheric LIDAR system that can map the distribution particles in the atmosphere at spatial resolutions as fine as 6 meters in nearly contiguous sample volumes distributed between 100 meters and about 10 kilometers. By scanning the device in azimuth and elevation, a hemispheric volume of radius 10 km can be sampled in a fraction of an hour. The ability to sample large volumes at this fine a spatial and temporal resolution can provide us with the means to make significant strides in our work that is not possible in any other way.

We are requesting funds to purchase a complete, self-contained, computer controlled scanning atmospheric LIDAR system. The unit operates at a wave length of 1.064 micrometers. The system consists of

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a YAG LASER with its power supplies and cooling unit, a 30 cm reflecting telescope focused on an detector, computer controlled scanning system and data acquisition system. The system power requirement is approximately 2 kilowatts. The system occupies about 1 cubic meter of space. It is readily portable in a small van and can be operated mounted on a variety of platforms. The laser pulse repetition rate can be varied up to 100 hertz allowing rapid sampling if desired. Estimated cost for the complete system is $377,400 plus applicable taxes.

The availability of the LIDAR system will make possible the detailed investigation of atmospheric phenomena related to airborne particles. The majority of these particles are derived directly and indirectly from energy systems. Both biomedically relevant and environmentally focused theoretical models of the behavior of gaseous and particulate emissions in the atmosphere can be validated and hypotheses can be tested with data collected with the LIDAR. No other methodologies can provide these data under realistic conditions. Source apportionment, which is now often a contested issue, can be better understood only if studies of sources, transport and dispersion of airborne materials can truly document detailed three dimensional distributions as a function of time. This is because the interaction of airborne particles from natural sources, those emitted directly and formed by gas-to-particle conversion processes, can only be investigated in a meaningful way with this kind of high resolution volumetric sampling. With a LIDAR, we will be able to design new research studies and better document conditions during more conventional studies, greatly enhancing the our ability to stay on the forefront of research in this important area.

1127306

OMB CONTROL NO. 1910-1400

U.S. DEPARTMENT OF ENERGY
UNIVERSITY RESEARCH INSTRUMENTATION PROGRAM
BUDGET PAGE

ESTIMATED COSTS

Instrumentation	Requested of DOE	Institution's Cost Sharing *(1)*	Other Federal Funds *(2)*	TOTAL
A. Purchase Price *(3)*	400,000			400,000
Maintenance *(4)*		X X X X X	X X X X X	
Subtotal:	400,000			400,000
B. Other Allowable Costs				
1. Shipping/Handling	X X X X X	2,000		2,000
2. Building/Laboratory Renovation	X X X X X			
Subtotal:				
C. TOTAL	400,000	2,000 *(5)*		402,000

NOTES:

(1) Non-Federal funds only. (However, may be provided by a third party.)

(2) Estimate funds to be obtained from other Federal agencies for purchasing the instrument, etc.

(3) Only the purchase price of the instrumentation is eligible for DOE funding through this program.

(4) See discussion of eligible maintenance costs on page 10.

(5) Only those costs specified above are eligible as cost sharing. Installation, operation, maintenance, travel and training costs, or faculty and student salaries, etc. are ineligible as cost sharing. Review discussion of eligible and ineligible costs on pages 10 and 11.

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A. Purchase Price (List components and unit prices.)

Description/Vendor	Quantity	Total Estimated Unit Price	Requested of DOE	Institution's Cost Sharing	Total
Atmospheric LIDAR Opteck, Inc.	1 EA	$377,400	$377,400	-0-	$377,400
+ Tax		22,600	22,600		22,600
Subtotal:		$400,000	$400,000		$400,000

112T080

OMB CONTROL NO. 1910-1400

DEPARTMENT OF ENERGY
UNIVERSITY RESEARCH INSTRUMENTATION PROGRAM
GRANT AND CONTRACT SUMMARY FORM

Institution Name: University of California, Davis

Current Grant/Contract/Subcontract No. (and contractor name if subcontract)	Principal Investigator	Title	Contract Date From MO	Contract Date From YR	Contract Date To MO	Contract Date To YR	Total Award Value	$ AMT Awarded for FY Period 1986 to 1988	DOE Technical Monitor/Location
DE-AG03-76SF 00472*	O. Raabe	Decontamination of Residual Radioactivity	10	88	10	89	200,000	200,000	J. Ricks/San Francisco Operations Office
DW89931796-01-0 with EPA	O. Raabe	Development of multiple compound pharmacobinetic modeling for exposure assessment	10	86	09	89	358,000	215,000	

Provide information only on those research projects which are *directly related* to the selected principal research area and which were active during the period from October 1, 1986 to September 30, 1988. Do not include grants or contracts for the following: (1) workshops, (2) education/training projects or other non-research projects, (3) facilities, (4) instrumentation, (5) those projects completed before October 1, 1986.

See discussion on page 8 for additional requirements relating to subcontracts.

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*NOTE: The Laboratory for Energy-related Health Research is operated under contract to DOE under DE-AC03-76SF 00472

RELATED FEDERAL AGENCY GRANTS AND CONTRACTS

Agency	Principal Investigator	Grant/Contract No.	Title	Grant/Contract/Dates FROM MO	FROM YR	TO MO	TO YR	Total Award Value
DOD: Naval Weapons Center China Lake, CA	R.G. Flocchini	N 60530-86-C-0351	Long Term Monitoring of Particles Affecting Visibility in the R2508 Air Space	07	86	07	89	$225,000
DOE: University Wide Energy Research Program	J.J. Carroll	UER-101-R5	Temporal and Spatial Distribution of O_3, Particles and NO_x in the Central Valley of California	07	88	06	89	17,100
NASA	J.J. Carroll	NAS8-36550	Airborne Doppler LIDAR Measurements of the Extended California Sea Breeze	03	86	03	88	98,000
USDA: Hatch	J.J. Carroll	UCD-4762-H	Urban and Rural Environmental Quality Protection	07	86	06	89	16,000
HSF	K.T. Paw U and R.H. Shaw Co.PI's	ATM-8703832	Turbulent Exchange of Heat, Mass and Momentum between the Atmosphere and a Plant Canopy	10	87	03	90	172,500
U.S. EPA	D.P.Y. Chang	CR-814869-01-0	Variables Affecting POHC Destruction and PIC Formation in a Research Combustor	04	88	04	89	45,288
U.S. EPA	D.P.Y. Chang	CR-81333-01-0	Spray Combustion Studies of Surrogate Hazardous Waste	04	89	06	87	61,969

Only provide information on research projects which are directly related to the selected principal research area.

112390

RELATED FEDERAL AGENCY GRANTS AND CONTRACTS

Agency	Principal Investigator	Grant/Contract No.	Title	Grant/Contract/Dates FROM MO	FROM YR	TO MO	TO YR	Total Award Value
NIEHS	Bruce Hammock D.P.Y. Chang Co PI's	ES-04699-0151	Biomarkers of Exposure to Hazardous Substances: Project II.5 Volatilization and Pyrolysis of Hazardous Wastes	09	88	08	92	$104,640
National Park Service/ US Environmental Protection Agency/ US Forest Service/Bureau of Land Management/Fish and Wildlife Service	Thomas A. Cahill	NPS# CX-0001-8-0017	IMPROVE (Interagency Monitoring of Protected Visual Environments)	07	88	06	93	$1,199,504
US National Park Service Criteria Pollutant Network	Thomas A. Cahill		Criteria Pollutant Network					

Only provide information on research projects which are directly related to the selected principal research area.

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Institutional history of energy related research

A number of faculty on the Davis campus of the University of California have been actively involved in energy related research for almost two decades. While some of this research has been directly concerned with energy production, the primary focus, especially of the group of faculty who prepared this proposal, has been and continues to be the environmental, biomedical, and public health consequences of energy production. Specifically, we collectively study various aspects of the production, diffusion, transport and fate of primary and secondary air pollutants. By this proposal we are requesting funds to purchase a tool of great importance to each of our areas of interest and to our collective research effort. This proposal is submitted by faculty from four departments in three colleges who have collaborated with one another in teaching, research and graduate student training for many years.

Professor Cahill is the head of the Air Quality Group housed in the Physics department. This group is comprised of a number of students, post doctoral scholars and a number of collaborating faculty including Professors Flocchini, Raabe and Carroll. The group primarily studies the distribution and elemental composition of airborne particles using ground based, balloon borne and aircraft samplers. These samples are analyzed using cyclotron-based techniques. The group uses the facilities of the Crocker Nuclear Laboratory which were developed and operated originally by the AEC (1965-71). The laboratory has become a major analytical facility in aerosol science using nuclear and atomic techniques to characterize atmospheric particles. The group has received extensive support in past years from DOE, U.S.E.P.A., the National Park Service, U.S. Forest Service, U.S. Fish and Wildlife Service, Bureau of Land Management and a number of state agencies, including the California Air Resources Board and California Department of Health Services. The major theme in all of these studies is the evaluation of the effect of energy technologies on the particulate concentrations in the atmosphere. Collaborative work has been performed with Lawrence Livermore National Laboratories and Los Alamos National laboratory, such as WHITEX (Winter haze intensive tracer experiment) in 1986. A comprehensive study of layered haze in the Grand Canyon is planned for 1989-90.

Professor Raabe, director of the Laboratory for Energy Related Health Research (LEHR) and Professor of Civil Engineering, has along been involved with significant research on the inhalation of particles and their effects on pulmonary toxicology. This laboratory is primarily funded through DOE for the study of biomedical effects of the airborne products of energy technologies. Historically a major emphasis of research at the laboratory was radiation biology. More recently, a strong program in inhalation toxicology has developed under Professor Raabe. This work has included development of sampling systems, generators to simulate natural exposure of test animals, and techniques for analyzing the results of these exposures.

Professor Chang is a member of the Environmental Engineering faculty within the Civil Engineering department. His interests include analysis of air quality improvement strategies and the air pollution problems associated with cogeneration facilities and waste disposal incinerators. He has diverse research interests which cover the broad spectrum of environmental engineering issues. A major interest of his is the development of pollutant emission control strategies, including the design of controls and evaluation of their performance. He has collaborated with Professor Raabe on the design of sampling and aerosol generating equipment and with Professors Carroll and Flocchini on measurement and analysis of particles and their effect on visibility, especially those that result from the combustion of agricultural wastes.

Professors Carroll, Paw U and Flocchini are in the department of Land, Air and Water Resources. Professor Carroll's interests include measurement and modeling of atmospheric transport and diffusion on spatial scales of a few hundred meters to a few hundred kilometers. He has extensive experience in the use of aircraft to monitor meteorological and air quality parameters. He has conducted studies of pollutant transport to remote areas and the emissions from open field burning of agricultural wastes. He has recently participated in the one of the first applications of a scanning airborne Doppler lidar system (developed by NASA scientists and engineers) to measure regional wind fields with a high degree of spatial resolution. These systems have been shown to have great potential to remotely measure detailed wind fields at time and space scales unattainable in any other way.He and his students are currently developing improved numerical algorithms for

use in non-hydrostatic atmospheric flow models. These models are being designed to predict pollutant diffusion and transport over regions up to a few hundred kilometers on a side.

Professor Flocchini's interests include use of particle sampling and analysis to identify source-receptor relationships and long range atmospheric transport of air borne particles. He was the organizer of the Western Fine Particle Network which has deployed a large number of particle samplers through out the arid west. This network was installed to establish baseline data on the particulate concentrations near the ground in rural and remote areas. The purpose of this study is to keep track of changes in the particulate distribution resulting from energy development in the west and the construction of fossil fuel power plants in these areas. He has also been active in documenting and explaining the presence of high pollutant levels in parts of the Sierra Nevada Mountains and in the Mojave Desert.

Professor Paw U's interests include the deposition and resuspension of particles over various surfaces. His research includes experimental and numerical modeling studies of fugitive dust resuspension and the role of turbulence in this process. He is also very active in the study of deposition of particles in plant canopies.

As we are an academic institution, all of our research work includes graduate students with a major share of the work performed being the basis for Masters theses and PhD dissertations.

The Instrument:

The instrument we seek is a LIDAR, a remote sensing device that measures the distribution of small particles suspended in the air much the same way that a RADAR maps the position of larger objects in space. The unit uses a pulsed YAG LASER, operating at a wavelength of 1.064 micrometers, as the energy source. The pulse width is nominally 10 nanoseconds and the maximum pulse frequency or repetition rate is 100 hertz. The minimum spatial resolution is about twice the pulse width or 6 meters. The actual resolution is selected by the choice of sampling interval for the detector. Energy scattered back by particles in the air is collected with a 30 cm telescope and focused on a solid state detector. The system has a maximum range of 5 to 10 km, depending on atmospheric conditions. The system is designed to scan from -20 to +90 degrees in elevation and 360 degrees in azimuth, allowing detailed

mapping of the particle distribution in spaces varying from a single line to a volume greater than a hemisphere.

The availability of LIDARs is very limited. There is one system operated by Stanford Research (SRI) which can be ground based or flown in an aircraft. A nonscanning LIDAR has also been developed by EPA Las Vagas and is primarily used in a downward looking mode in an aircraft. NASA Goddard in Virginia has two such systems. Doppler systems, using carbon dioxide lasers have been developed by NASA at Marshall Space Flight Center, AL. and by NOAA at the Wave Propagation Laboratory in Boulder, CO. The National Center for Atmospheric Research in Boulder is currently developing a similar Doppler system. Professor Carroll has worked with data from the NASA system, obtaining wind fields from their Doppler LIDAR data. These carbon dioxide systems are much more expensive than the YAG system requested here and are not well suited to the applications we envision. The University of Wisconsin has developed a very high powered, fast scanning system used primarily to map turbulent structures in the atmospheric boundary layer. There are also several powerful vertically pointing LIDAR systems in use in Hawaii, Germany, Switzerland and Japan to probe the stratosphere and higher in the atmosphere. There are undoubtedly other systems in use, but the number is small.

Instrument utilization:

An instrument of this type would give us the capability to advance fundamental knowledge of atmospheric transport and diffusion processes and of turbulent structures in the atmosphere. Data obtained from this system allows documentation of air quality problems and insight into the causes and critical characteristics of these problems. Data from this type of system provide unique opportunities to verify predictions of models while at the same time providing important clues as to why prediction failures may be encountered. The importance of obtaining measurements that are continuous in time and space over regions 5 to 10 km in radius cannot be over stated. This and other forms of remote sensing of natural phenomena are now becoming the means for advancing our fundamental understanding of these phenomena and for evaluating the effectiveness of applications derived from this understanding.

A major fraction of particles suspended in the air is formed directly and indirectly from the production and combustion of carbon

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based fuels. While there are many pollutant emissions not directly resulting from energy production and utilization, there is a strong correlation between total pollutant loads, energy related emissions and total ambient particle concentrations. Hence particle concentration is a good surrogate for general air quality in most instances, when primary emissions have aged at least a few hours. Knowledge of the three dimensional distribution of pollutants and how this distribution varies with time is critical for verification of models predicting atmospheric mean flows, turbulent diffusion, atmospheric chemical reactions (especially gas to particle conversions), and the dispersion of materials from individual sources. We recognize that all pollutants are not particles, but particle concentration is a good surrogate for the general pollutant load in the atmosphere. Particles impact many processes in the atmosphere (e.g. radiative transfer, cloud microphysics, acid precipitation); can be ingested by respiring organisms increasing morbidity and mortality in these organisms and are the cause of a variety of visibility related problems. Documentation of the detailed temporal and spatial distribution of particles is generally limited to isolated point samples taken over periods of hours to days. A lidar system can provide detailed information with high spatial and temporal resolution for periods of a few hours to seasonal time scales. The operational costs for the use of this device are comparable to single site, in situ techniques.

Air pollution control agencies need to develop strategies to attain compliance with state and federally mandated ambient air quality standards. A major tool used to develop these strategies is the evaluation of the effect of proposed emission controls through the use of "airshed models". These models are comprised of three main sub models: emissions, meteorology and chemistry. While they are very complex models they include many relatively simple parameterizations of real processes. Careful assessments of these models are needed to define their reliability, before major policy decisions are made regarding emission control strategies. Data sets useful for verification of these models are very hard to obtain using standard in situ techniques. Point measurements taken primarily near the ground do not represent the same information as calculated by the model. These models predict average concentrations within each model cell. These cells are the order of 2 km on a side and 0.5 km deep or larger. Remote

sensing techniques capable of providing spatially continuous data in volumes containing multiple model cells are the best ways to obtain verification data for these models. Since these model include emission of particles and gas to particle conversions, data on particle distributions in time and space constitute a significant means to evaluate model performance. Several field programs are being planned to seek verification data for these models(e.g. the $10,000,000 California San Joaquin Valley study planned for 1989-91), the majority of measurements in these programs will be in situ measurements at ground level which severely limit their ability to check critical aspects of these models. LIDAR measurements would greatly add to the value of these studies. Several of us will be involved with aspects of the California program (Cahill, Carroll, Chang, Flocchini).

The impact of urban and transportation emissions on remote areas, especially national parks and forests, is in increasing concern. Many remote areas, such as Lake Tahoe, Yosemite, and the Grand Canyon are plagued by deteriorating air quality, especially as evidenced by reduced visibility. The ability to continuously map the clouds of particles within and around these and other pristine areas provides documentation of the nature and extent of the problem. These measurements can also help determine the transport mechanisms responsible for the air quality degradation. Cahill, Carroll and Flocchini have been investigating these problems for a number of years but progress has been slowed by the severe limitations imposed by in situ measurement techniques. Even with the use of aircraft sampling, there remains the inability to "close" the problem and establish an unambiguous description of the processes and mechanisms operating. Documentation of the extent of the problem and of the physical phenomena that determine impacts in complex terrain is especially difficult. On the one hand, the topography limits the placement of in situ samplers to readily accessible locations. On the other hand, the complexity of the topography implies that point measurements are not likely to be representative of any but the immediate surroundings of the sampler. Remote sensing techniques are the best ways to address this question since as long as an unobstructed view can be had, the particle concentrations, even over the steepest terrain, can be determined.

With the growing political and societal concern for carbon dioxide induced climate change, national energy policy will be debated over the coming decade. A major element in that debate will be the substitution of alternate energy sources for carbon based fuels. One proven alternative is nuclear fission. Public resistance to nuclear energy is partly due to fear of plant accidents and partly due to concern for nuclear waste management. A major mitigation strategy for the problem of accidental releases of hazardous material is the use of real time transport and dispersion models to define the areal extent and degree of danger. An example of this is the ARAC program at Lawrence Livermore National Laboratory. As with the airshed models, point measurements do not give the kind of volumetric information needed to evaluate accuracy of model predictions. Using the LIDAR to observe the dispersion from a source, model performance can be assessed and improvements made as needed. This kind of study is straight forward for the type of system sought and extremely difficult to execute using in situ techniques. Even with aircraft sampling, one cannot sample the whole volume on a time scale which is short relative to the time scale of the dispersion process.

Increasingly the nation is turning to waste combustion as a means for energy recovery and reducing waste volume. There are few alternatives to such practices with recent bans on land disposal and a dwindling supply of suitable landfill sites. Some of these combustion units are also used in conjunction with the co-generation of electrical power as well as process steam. The generation of several percent of the nation's electrical power needs has been estimated to be possible through such projects. Additionally, co-generation of electrical power by industries generating process steam has also taken hold in several areas of the country, especially in California where legislatively mandated incentives exist. Unfortunately, both of these types of units are often located in urban areas and concerns over pollutant emissions is increased, often requiring detailed model studies of pollutant dispersion. More and more, regulatory agencies are turning to health risk estimation as a means for making permitting decisions. A premium is therefore placed upon accurate assessment of projected ambient concentrations, whether or not supporting human health risk data warrant such accuracy.

Air pollution dispersion models are applied in order to make such risk estimates. It is well known that one of the weakest links in such models is the estimation of plume rise. The near-field concentrations, which can be the most important in exposure estimation methodologies currently employed, are highly sensitive to the estimated plume rise. The database upon which most plume rise estimation methods rely is largely based upon observations taken at large power plants and was developed under Department of Energy sponsorship. However, the new waste-to-energy and co-generation plants tend to be smaller with lower heat emission rates and are thereby subject to greater influence of surrounding topography. There is a clear need to increase the range of applicability of the plume rise estimation models. The LIDAR unit proposed would be extremely valuable for tracking such plumes because of the fine particulate matter contained in almost all plumes from waste combustion. The unit would be used to increase the quality of the database from which plume rise models, applicable to small heat emission sources in urban topography, can be developed. This is a logical extension of the work that Dr. Chang is engaged in, i.e., the study of waste combustion, and would be carried out in collaboration with Dr. Carroll.

In a more fundamental context, the interaction of atmospheric turbulent motions with loose material on the ground results in resuspension of these materials into the air. The mechanism for this is only poorly understood. Resent turbulence research suggests that this resuspension if forced by organized structures in the turbulent flow near the surface. These flow structures are nearly impossible to define using in situ measurement techniques. With the introduction of smoke or other tracer particles, a LIDAR system is fully capable of providing three dimensional visualization of these events and definition of their structures as they evolve in time. Professor Paw U has examined deposition and resuspension problems in plant canopies as well as in wind tunnels. Professors Cahill, Carroll and Raabe are attempting to develop and verify models for predicting resuspension, transport, diffusion and deposition of particles from natural surfaces. The major difficulty we are experiencing is the inability to obtain the spatially dense measurements with the high temporal resolution needed to verify these models.

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Budget discussion:

We have made inquiries seeking vendors of such systems and have found one manufacturer of a full LIDAR system: Optech inc. of Ontario Canada. The cost for a complete system (LIDAR, power supplies, data acquisition system and controlling computer) is estimated to be $377,400 US, plus applicable taxes and shipping. We assume that no duty would be due if the Canadian vendor were in fact chosen. Local sale tax has been added to the estimated price to bring the total request to $400,000. While the initial cost of the system is high, operational costs are low and comparable to those for the operation of a single point sampler. The unit requires only modest power (2 KW) and does not use chemicals or other expendables. It can be operated by two easily trained observers. The system is fully computer controlled with the scanning and data acquisition parameters entered in real time. Data acquired is stored directly on computer compatible media as well as being available on a real time display. The latter feature allows the operator to optimize the data acquisition to the conditions at hand.

The system is relatively maintenance free. The useful live of the LASER is the major limitation of the useful life of the system. At this writing we do not have a firm estimate for the life of the laser. Our best estimate is at least 5 years at moderate use. Laser repair/replacement costs are between $10,000 and $30,000. The mechanical and electronic parts should last well over 15 years with reasonable preventive maintenance. The unit requested is a self-contained, complete scanning device. We will provide appropriate housing for it. A generator, mountings, and operating enclosures for mobile deployment will be developed by us from funds other than this request. The department of L.A.W.R. maintains a motor home that has bee converted to a mobile laboratory. It is equipped with generator, air conditioning, leveling jacks and other features that would support the field deployment of the LIDAR system.

112700

APPENDIX 1

Resumes for:

John J. Carroll
Thomas Cahill
Daniel P.Y. Chang
Robert G. Flocchini
Kyaw Tha Paw U
Otto G. Raabe

1127601

Curriculum Vitae: John J. Carroll

Professor of Atmospheric Science
Dept. of Land, Air and Water Resources
University of California, Davis CA 95616
(916)752-3245

Education: [redacted]

Experience: Consultant to McDonnell-Douglas Astronautics Company 1967-1969. Faculty of University of California, 1969-present. Consultant to various energy developers (Western Oil and Gas Association; Geothermal developers) and Air Quality Control agencies (California Air Resources Board, Lake and Sonoma county air quality management districts) on atmospheric pollutant transport and diffusion. Principle investigator on grants and contracts from NSF (studies of energy exchange near the ground at South Pole 1974-84), DOE (Solar Energy Monitoring, Research and Training, 1977-81); NASA (Evaluation of Doppler LIDAR Techniques for wind measurements, 1981-88) and studies (funded by various federal and non-federal sources) of air pollution transport in complex topography; emission from combustion of agricultural wastes; the development of predictive atmospheric transport and diffusion models applicable on local (< 1 km) and regional (≤ 100 km) scales and design of field measurement programs to obtain data for model validation

Selected Publications:

Carroll, J.J. and R.L. Baskett. 1979. Dependence of the air quality in the Yosemite Valley on local and mesoscale transports: A case study. Journal of Applied Meteorology. 18(4):474-486.

Carroll, J.J. 1984. Effects of stratospheric aerosol on the measured shortwave radiation incident at the ground. Jl.Geophysical Research 89:D2, 2553-2561.

Carroll, J.J. 1986. On the accuracy of wind measurements using an airborne doppler lidar. Jl. Atm. Oc. Technology 3:(1):3-11.

Carroll, J.J. L.R.-Mendez-Nunez and S. Tanrikulu. 1987. Accurate pressure gradient calculations in hydrostatic atmospheric models. Boundary-layer Meteor. V. 41, No 1-4, 149-169.

Carroll, J.J. 1988. Analysis of Airborne Doppler LIDAR Measurements of the Extended California Sea Breeze. Accepted for publication in: Jl. Atmos. and Oceanic Technology.

112402

Curriculum Vitae: Thomas A. Cahill

Director, Crocker Nuclear Laboratory
Professor of Physics
Dept. of Physics
University of California, Davis, CA 95616
(916) 752-4213

Education: [redacted]

Experience: Professor Cahill has had a number of administrative posts within the University as well as being an active educator and researcher. As Leader of the Air Quality Group, an outgrowth of the AEC Funded Crocker Nuclear Laboratory, he has conducted a large number of studies of the character and distribution of atmospheric aerosols. Contracts and grants in which he is principle investigator generate about $500,000 per year, mostly from USEPA and USDA Forest Service.

Selected Publications:

Cahill, T.A. 1986. Physical methods in air pollution research: The second decade. Physics in Environmental and Biomedical Research 55-61, editors S. Onori and E. Tabet.

Eldred, R.A., T.A. Cahill, P.J. Feeney. 1986. Particulate monitoring at U.S. national parks using PIXE. Nuclear Instruments and Methods in Physics Research. B22:289-295.

Cahill, T.A., R.A. Eldred, D. Wallace, and B.H. Kusko. 1986. The hydrogen-sulfur correlation, by PIXE plus PESA, and aerosol source identification. Nuclear Instruments and Methods in Physics Research B22:296-300.

Cahill, T.A., P.J. Feeney, R.A. Eldred, W.C. Malm. 1987. Size/time composition data at Grand Canyon National Park and the role of ultrafine sulfur particle. Proceedings of APCA Specialty Conference "Visibility Protection-Research and Policy Aspects", Grand Teton National Park, Wyoming, September 7-10, 1986. p. 657.

Eldred, Robert A., T.A. Cahill, and P.J. Feeney. 1987. Particle monitoring at U.S. national parks using PIXE. Nuclear Instruments and Methods in Physics Research. B22:289-295.

1127603

Curriculum Vitae: Daniel P.Y. Chang

Department of Civil Engineering
University of California, Davis
(916) 752-2537

Education: [redacted]

Experience: 7/73 to present - Professor, Department of Civil Engineering, University of California, Davis. Research interests have involved the physico-chemical properties of aerosols, their effects on human health, toxic volatile organic compounds, and combustion of wastes. Current sponsored research projects involve the sampling and analysis of toxic volatile organic chemicals at publicly owned treatment works, and the combustion of wastes (liquid chlorinated organic waste, agricultural waste and biomedical waste). Appointed to the California Air Resources Board Research Screening Committee '79-'84. Visiting Scientist Battelle Pacific Northwest Laboratory '79-80, Visiting Research Engineer, U.S. EPA Hazardous Waste Engineering Research Laboratory '86-87.

Selected Publications:

N. W. Sorbo, R.R. Steeper, C.K. Law and D.P.Y. Chang. "An Experimental Investigation of the Incineration and Incinerability of Chlorinated Alkane Droplets." Proc. of the 22nd (International) Symposium on Combustion, University of Washington, Seattle, WA, August 14-19, 1988.

D.P.Y. Chang, R.E. Mournighan, and G.L. Huffman. "Thermodynamic Analysis of Post-flame Reactions Applied to Waste Combustion." Proc. of the 13th Annual Research Symposium on Land Disposal, Remedial Action, Incineration and Treatment of Hazardous Waste, Cincinnati, OH, May 6-8, 1987.

N. W. Sorbo, R.R. Steeper, D.P.Y. Chang, and C.K. Law. "Incineration of Liquid Hazardous Wastes: Vaporization and Combustion of Droplets of Chlorinated Hydrocarbons." Proc. of the 1987 Spring Technical Meeting of the Central States Section of the Combustion Institute, Argonne, IL. May 11-12, 1987.

D.P.Y. Chang, N.W. Sorbo G.S. Murchison R.C. Adrian and D.C. Simeroth. "Evaluation of a Pilot-scale Circulating Bed Combustor as a Potential Hazardous Waste Incinerator." Journal of the Air Pollution Control Association, 37(3):266-274, 1987.

D.P.Y. Chang, N.W. Sorbo, G.S. Murchison, R.C. Adrian and D.C. Simeroth. "Incineration of Surrogate Hazardous Waste in Pilot and Full-scale Combustors." Proc. of the Seventh World Clean Air Congress, Sydney, Australia, Vol.III, pp.308-315, 1986.

112704

Curriculum Vitae: Robert G. Flocchini

Department of Land, Air and Water Resources
University of California, Davis CA 95616
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Education: [redacted],

Experience: 1975-78: Lecturer (Physics), University of California, Davis; 1978-80: Lecturer (Land, Air and Water Resources), University of California, Davis; 1980-present: Professor, University of California, Davis.

Selected Publications:

Flocchini, R.G., P.J. Feeney, R.J. Sommerville and T.A. Cahill. 1972. Sensitivity versus target backings for elemental analysis by alpha excited x-ray emission. Nuclear Instruments and Methods 100:397-402.

Flocchini, R.G., T.A. Cahill, D.J. Shadoan, S.J. Lange, R.A. Eldred, P.J. Feeney, G.W. Wolfe, D.C. Simmeroth and J.K. Suder. 1976. Monitoring California's aerosols by size and elemental composition. Environmental Science and Technology 10:76-82.

Flocchini, R.G., T.A. Cahill, Marc L. Pitchford, R.A. Eldred, P.J. Feeney and L.L. Ashbaugh. 1981. Characterization of particles in the arid west. Atmospheric Environment 15(10/11): 2017-2030.

R.F. Kamada and R.G. Flocchini. 1984. Gaussian thermal flux model-I. theory. Solar Energy 32(4):505-514.

R.F. Kamada and R.G. Flocchini. 1984. Gaussian thermal flux model-II. validation. Solar Energy 32(4):515-521.

112705

Curriculum Vitae: Kyaw Tha Paw U

Department of Land, Air and Water Resources
University of California, Davis, CA 95616
(916)752-1510

Education: [redacted]

Experience: 1980-84, Assistant Professor Boundary Layer Meteorology & Biometeorology, Purdue University; 1984-1988, Assistant Professor of Biometeorology, University of California; 1988-present, Associate Professor, University of California

Activities in Academic, Professional and Scholarly Societies

Chair, Committee on Biometeorology and Aerobiology, American Meteorological Society, 1985-1987

Program Chair, Seventh Conference on Biometeorology and Aerobiology, held in Scottsdale, Arizona, May 21-24, 1985; organized by the American Meteorological Society.

Selected Publications:

Gao, W., R.H. Shaw and K.T. Paw U. Observations of organized structures in turbulent flow within and above a forest canopy. Boundary-layer Meteorol., in press.

Paw U, K.T. and W. Gao., 1988. Applications of solutions to non-linear energy budget equations. Agric. and Forest Meteorol., 43:121-145.

Meyers, T.P. and K.T. Paw U, 1987. Modelling the plant canopy micrometeorology with higher-order closure principles. Agric. and Forest Meteorol., 41:143-163.

Braaten, D.A., R.H. Shaw, and K.T. Paw U. 1986. Particle detachment in turbulent boundary layers. in Aerosols: Formation and Reactivity. Pergamon Press, New York, pp. 370-373.

Paw U, K.T., R.H. Shaw, and T.P. Meyers. 1985. Evaporation as modelled by a higher order closure scheme. In Advances in Evapotranspiration. pp. 43-50.

1127606

Curriculum Vitae: Otto G. Raabe

Professor-in-Residence,
Department of Veterinary Pharmacology and Toxicology
(School of Veterinary Medicine), and
Department of Civil Engineering,
University of California, Davis, CA 95616

Director
Laboratory for Energy-related Health Research,
University of California, Davis, CA 95616.

EDUCATION: [redacted]

RESEARCH INTERESTS

Airborne Toxics, Inhalation Toxicology, Environmental Engineering, Aerosol Science, Airborne Particle Sampling and Characterization, Inhalation Exposure Equipment and Methods, Biophysics, Carcinogenesis, Dose-response Relationships.

HONORS, MEMBERSHIPS, AND ADDITIONAL INFORMATION

Recipient (March 1980) of Society of Toxicology's Frank R. Blood Award for best research publication during 1979 in TOXICOLOGY AND APPLIED PHARMACOLOGY.

Phi Kappa Phi; American College of Toxicology; American Industrial Hygiene Association; American Association for Aerosol Research; American Conference of Governmental Industrial Hygienists; American Association for the Advancement of Science; Air Pollution Control Association; Health Physics Society, Gesellschaft fur Aerosolsforschung, American Chemical Society (Environmental Division).

Member, County of Sacramento Air Pollution Control District Toxic Substances Technical Advisory Committee, 1983-present.

Chairman, University of California, Davis, Radiation Safety Administrative Advisory Committee, 1984-1986; member 1988-present.

Certified for Comprehensive Practice: American Board of Health Physics (1970). President-elect, American Academy of Health Physics, 1988.

SELECTED PUBLICATIONS:

Raabe, O.G., D.A. Braaten, R.L. Axelbaum, S.V. Teague, and T.A. Cahill, Calibration studies of the DRUM impactor. J. Aerosol Science 19:183-195, 1988.

Raabe, O.G. Basis for particle size-selective sampling for beryllium. Chapt. 4 in Advances in Air Sampling, Lewis Publishers, Inc., Chelsea, MI: 39-51, 1988.

Schreider, J.P., M.R. Culbertson, and O.G. Raabe. Comparative pulmonary fibrogenic potential of selected particles. Environ. Res. 38: 256-274, 1985.

Raabe, O.G. Size-selective sampling criteria for thoracic and respirable mass fractions. Ann. Amer. Conf. Govern. Ind. Hyg. 11: 53-65, 1984.

Raabe, O.G. and F.J. Miller. Respiratory tract deposition and fate of inhaled aerosols and sulfur dioxide, Chapter 11 in AIR QUALITY CRITERIA FOR PARTICULATE MATTER AND SULFUR OXIDES, EPA-600/8-82-029, pp. 11-1 to 11-74, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1982.

OMB CONTROL NO. 1910-0400

U.S. DEPARTMENT OF ENERGY

ASSURANCE OF COMPLIANCE

Nondiscrimination in Federally Assisted Programs

(Hereinafter called the "Applicant")

(Name of Applicant)

HEREBY AGREES to comply with Title VI of the Civil Rights Act of 1964 (Pub. L. 88-352), Section 16 of the Federal Energy Adminstration Act of 1974 (Pub. L. 93-275), Section 401 of the Energy Reorganization Act of 1974 (Pub. L. 93-438), Title IX of the Education Amendments of 1972, as amended, (Pub. L. 92-318, Pub. L. 93-568, and Pub. L. 94-482), Section 504 of the Rehabilitation Act of 1973 (Pub. L. 93-112), the Age Discrimination Act of 1975 (Pub. L. 94-135), Title VIII of the Civil Rights Act of 1968 (Pub. L. 90-284), the Department of Energy Organization Act of 1977 (Pub. L. 95-91), and the Energy Conservation and Production Act of 1976, as amended, (Pub. L. 94-385). In accordance with the above laws and regulations issued pursuant thereto, the Applicant agrees to assure that no person in the United States shall, on the ground of race, color, national origin, sex, age, or handicap, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity in which the Applicant receives Federal assistance from the Department of Energy.

Applicability and Period of Obligation

In the case of any service, financial aid, covered employment, equipment, property, or structure provided, leased, or improved with Federal assistance extended to the Applicant by the Department of Energy, this assurance obligates the Applicant for the period during which Federal assistance is extended. In the case of any transfer of such service, financial aid, equipment, property, or structure, this assurance obligates the transferee for the period during which Federal assistance is extended. If any personal property is so provided, this assurance obligates the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance obligates the Applicant for the period during which the Federal assistance is extended to the Applicant by the Department of Energy.

Employment Practices

Where a primary objective of the Federal assistance is to provide employment or where the Applicant's employment practices affect the delivery of services in programs or activities resulting from Federal assistance extended by the Department, the Applicant agrees not to discriminate on the ground of race, color, national origin, sex, age, or handicap, in its employment practices. Such employment practices may include, but are not limited to, recruitment, recruitment advertising, hiring, layoff or termination, promotion, demotion, transfer, rates of pay, training and participation in upward mobility programs, or other forms of compensation and use of facilities.

Subrecipient Assurance

The Applicant shall require any individual, organization, or other entity with whom it subcontracts, subgrants, or subleases for the purpose of providing any service, financial aid, equipment, property, or structure to comply with laws cited above. To this end, the subrecipient shall be required to sign a written assurance form, however, the obligation of both recipient and subrecipient to ensure compliance is not relieved by the collection or submission of written assurance forms.

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Data Collection and Access to Records

The Applicant agrees to compile and maintain information pertaining to programs or activities developed as a result of the Applicant's receipt of Federal assistance from the Department of Energy. Such information shall include, but is not limited to, the following: (1) the manner in which services are or will be provided and related data necessary for determining whether any persons are or will be denied such services on the basis of prohibited discrimination; (2) the population eligible to be served by race, color, national origin, sex, age and handicap; (3) data regarding covered employment including use or planned use of bilingual public contact employees serving beneficiaries of the program where necessary to permit effective participation by beneficiaries unable to speak or understand English; (4) the location of existing or proposed facilities connected with the program and related information adequate for determining whether the location has or will have the effect of unnecessarily denying access to any person on the basis of prohibited discrimination; (5) the present or proposed membership by race, color, national origin, sex, age and handicap, in any planning or advisory body which is an integral part of the program; and (6) any additional written data determined by the Department of Energy to be relevant to its obligation to assure compliance by recipients with laws cited in the first paragraph of this assurance.

The Applicant agrees to submit requested data to the Department of Energy regarding programs and activities developed by the Applicant from the use of Federal assistance funds extended by the Department of Energy. Facilities of the Applicant (including the physical plants, buildings, or other structures) and all records, books, accounts, and other sources of information pertinent to the Applicant's compliance with the civil rights laws shall be made available for inspection during normal business hours on request of an officer or employee of the Department of Energy specifically authorized to make such inspections. Instructions in this regard will be provided by the Director, Federally Assisted Programs Division, Office of Equal Opportunity, U.S. Department of Energy.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts (excluding procurement contracts), property, discounts or other Federal assistance extended after the date hereto, to the Applicant by the Department of Energy, including installment payments on account after such date of application for Federal assistance which are approved before such date. The Applicant recognizes and agrees that such Federal assistance will be extended in reliance upon the representations and agreements made in this assurance and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, as well as the person whose signature appears below and who is authorized to sign this assurance on behalf of the Applicant.

November 29, 1988
(Date)

The Regents of the University of California
(Name of Applicant)

Office of Research, 275 Mrak Hall
Davis, California 95616
(Address)

(Authorized Official)

(916) 752-2075
(Applicant's Telephone Number)

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