State of California
AIR RESOURCES BOARD

Resolution 84-54

November 30, 1984

Agenda Item No.: 84-16-2

WHEREAS, Health and Safety Code Section 39701 requires the Air Resources Board (the "Board") to coordinate and collect research data on air pollution, and Health and Safety Code Section 39703 authorizes the Board to establish applied research objectives, to receive and review research proposals, to recommend specific research projects, and to establish necessary administrative and review procedures;

WHEREAS, Health and Safety Code Section 39705 directs the Board to appoint a screening committee of scientific and engineering experts to review, and to give its advice and recommendations with respect to, all air pollution research projects funded by the state;

WHEREAS, on March 22, 1984, the Board met with the Research Screening Committee during a duly noticed public meeting to review and discuss the Board's research program;

WHEREAS, the Board has considered issues relating to the role and functioning of the Research Screening Committee and has received public comment on these issues at public hearings held April 27, 1984, and May 24, 1984;

WHEREAS, the Board, by Resolution 84-12, has resolved to pursue a policy of close liaison between the Board and the Research Screening Committee as a means of ensuring that the Board is aware of the latest developments in the research program and that the Committee is fully apprised of the Board's regulatory priorities as they apply to the research program;

WHEREAS, the Board staff, with the advice and assistance of the Research Screening Committee, has developed a proposal for a long-range plan for extramural research which is consistent with the Board's expressed research priorities and with the statutory requirements for the Board's research program;

WHEREAS, the Research Screening Committee has reviewed and recommended that the Board approve the proposed Long-Range Research Plan as set forth in Attachment A hereto;

WHEREAS, within 60 days, the staff will identify, for the Board's approval, specific recommendations for research activities within the categories identified in the Long-Range Research Plan;

WHEREAS, the California Environmental Quality Act and Board regulations require that an activity not be approved as originally proposed if feasible alternatives or mitigation measures are available which would reduce any significant adverse impacts the activity may have on the environment;

WHEREAS, the Board has considered the proposed Long-Range Research Plan at a duly noticed public meeting; and

WHEREAS, the Board finds that

The proposed Long-Range Research Plan accurately sets forth the goals and objectives of the Board's research program and identifies to a reasonable degree the specific research topics which will lead toward achievement of those goals and objectives;

The research priorities reflected in the allocation of funds among research categories in the proposed Long-Range Research Plan are consistent with the Board's current and future regulatory priorities; and

The proposed action will have only beneficial effects on the environment.

NOW, THEREFORE, BE IT RESOLVED that the Board approves the Long-Range Research Plan, as set forth in Attachment A hereto, and directs the Executive Officer to implement the plan subject to available funds in accordance with the existing procedures established by the Board.

I hereby certify that the above is a true and correct copy of Resolution 84-54, as adopted by the Air Resources Board.

Harold Holmes, Board Secretary

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I. INTRODUCTION

In accordance with the California Health and Safety Code (Sections 39700-39706, Attachment A), ARB conducts a comprehensive program of research into the causes, effects and possible solutions to the air pollution problem in California.* The Health and Safety Code further provides (Section 39701) that the Board shall coordinate and collect research data on air pollution in several specified categories of research. Generally, these categories are: effects of air pollution; emissions inventory and control technology; atmospheric processes; meteorology, forecasting, and modeling; and air quality measurement and data analysis. The ultimate objective of the research program is to provide timely scientific and technical information needed for public policy decisions to operate an effective air pollution control program in California. Consistent with these needs and its statutory mandate, the ARB has defined six major research problems which reflect ARB's current priorities and needs for detailed scientific and technical information. These problems and knowledge gaps are:

a. Emissions from diesel-powered vehicles;
b. Toxic air contaminants;
c. Air pollution damage to agricultural crops;
d. Other air pollution health effects and standards review;
e. Regional Air Pollution Studies; and
f. Reducing emissions from mobile and stationary sources, other than diesels.

*Acid deposition research, which has been the subject of two recent Board meetings, is provided for under a separate chapter of the Health and Safety Code (Chapter 6, Sections 39900-39915) and, except as noted, is excluded from the discussion that follows. For those interested, a discussion and outline of the Board's long-range plans for acid deposition research and monitoring may be found in the Board's first annual report, entitled "Acid Deposition Research and Monitoring Program, Report to the Governor and Legislature", December 1983.

In the long-range research plan (Chapter II), these research problems are developed into a series of general goals and objectives which, in turn, are described by candidate research projects. The overall plan represents ARB's best current perception of future problems which should be addressed, in part, through extramural research. Many of the projects for the current fiscal year (1984-85) have already been started; these are shown primariliy for continuity. Detailed projects for the later years, 1985-86 and 1986-87, will be refined with greater specificity in the future, depending upon updated needs and results from ongoing studies. Accordingly, the research plan contained herein is intended to be flexible and adaptable to changing needs.

Beginning in 1984, the ARB intends to prepare and disseminate to interested parties its comprehensive long-range plan for air pollution research in California. Development of this plan begins with a survey and analysis of research problems. Identification of problems and needed projects originate with the identification of a relevant scientific or technical problem by the Legislature, by the Board, by ARB staff, local air pollution control district staffs, by Board advisory committees, such as the Agricultural Advisory Committee, or by independent scientific investigators in the academic community and elsewhere. Such problem statements are often accompanied by requests (or legislative mandates) for research studies, sometimes including detailed project objectives and research plans. This process is formalized in California through an annual zero-based* budget process. An initial research plan proposal is drafted annually by the Board staff and, after review and amendment (as necessary) by the Board Chairman and Secretary of Environmental Affairs, is submitted to the Governor for consideration in the Administration's budget proposal. The research budget proposal is subsequently reviewed by the Legislature's fiscal committees before funds are appropriated.

Once approved by the Board, the ARB's long-range research plan is intended to serve as a guide to all interested parties, particularly with regard to candidate research topics.

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As in the past, air pollution research proposals will be reviewed, in conformance with statutory requirements (Health and Safety Code Sections 39701, 39703-39705), by the Board staff and by the Research Screening Committee, which provides independent scientific and technical peer review (see Attachment B). Once initiated, each research contract will be monitored by the Research Division to ensure that projects stay on target and on schedule. Historically, most research projects have required from 12 to 36 months (statutory limit) for the contractor to complete the work. Upon completion of the research portion of the project, contractors prepare draft final reports which are then reviewed by staff and the Research Screening Committee. Final reports are then prepared by the contractor, and copies are forwarded to the ARB for distribution internally, to districts, and to other interested persons through the National Technical Information Service (a federal agency).

The ARB research program coordinates research efforts and exchanges information with a number of interested agencies and with the scientific and technical communities at large. Primary contacts are:

1. Local Air Pollution Control Districts sometimes represented by CAPCOA (California Air Pollution Control Officers' Association)
2. USEPA (United States Environmental Protection Agency)
3. CEC (California Energy Commission)
4. CDAWG (California Desert Air Working Group)
5. SAWG (State Agency Working Group on Acid Deposition)
6. Scientific and Technical communities at large

The research plan contained in Chapter II has been reviewed and approved by the Board's Research Screening Committee. A letter from the Chairman of the Committee is attached (Attachment D).

*A zero-based budget requires annual analysis and justification of each budget item to arrive at a total budget for the year, rather than specifying a baseline funding level which would subsequently be disaggregated by project area.

II. LONG-RANGE RESEARCH PLAN

This chapter describes each of the six major research problems which have been identified as crucial to the overall success of the Board's efforts to maintain an effective air pollution control program in California. In addition, the outline following each section summarizes the Board's goals and objectives for research and lists candidate research topics to address the respective problems.

A. EMISSIONS FROM DIESEL-POWERED VEHICLES

Particles emitted from light-duty (LD) and heavy-duty (HD) diesel-powered vehicles have been of increasing concern in recent years due to potential for adverse human health effects and significant effects upon atmospheric visibility and soiling. More precise determination of such health risks and the development of measures to reduce diesel emissions from all classes of vehicles are high priorities for ARB research. Nationally, the EPA is addressing similar problems, but California has taken the lead in promulgating and adopting more stringent emission standards for diesel vehicles. Such actions are necessary because air pollution problems are exacerbated in California by stagnant atmospheres and pollutant concentration buildups in some areas, especially the South Coast and San Joaquin Valley Air Basins.

Diesel fuel use and emissions from diesel-fueled vehicles have been increasing as diesels have penetrated further into the total vehicle fleet. This trend is expected to continue in the future. The emissions of greatest concern are particulate matter and oxides of nitrogen. In 1983, diesel-fueled vehicles emitted about 80 percent of the 61 tons per day of particulate emissions from statewide mobile sources (on-road vehicles). By 1995, diesel-fueled vehicles are projected to emit about 90 percent of the 110 tons per day of particulate emissions estimated for statewide mobile sources. For oxides of nitrogen (NOx) emissions, which are precursors of nitric

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acid formation in the atmosphere, diesel-fueled vehicles accounted for about 33 percent of the 1630 tons per day of NOx emissions from Statewide mobile sources in 1983. By 1995, these vehicles are projected to emit about 60 percent of 1380 tons per day of NOx emissions from the same source categories.

Currently, the ARB is sponsoring research projects to investigate the effects of acidity on the lung, using simulated urban atmospheres (diesels emit both sulfur oxides and nitrogen oxides which form acids in the atmosphere), to evaluate the retention of inhaled toxic pollutants (diesels emit many toxic organic compounds, most notably polycyclic organic materials), and to develop and demonstrate a catalytic trap oxidizer to reduce particulate exhaust from diesel buses (smoke from city buses is a major source of complaints from the public).

The ARB's three-year plan to address these problems (see outline at the end of this section) includes both an ongoing assessment of health risks and phased efforts to: more fully characterize HDV and LDV exhaust emissions; develop and demonstrate HDV emission control technologies (particulate traps); determine the feasibility of a field inspection program for heavy-duty diesels; evaluate the effects of changes in diesel fuel composition; and carry out studies to characterize diesel-emitted hydrocarbons and associated particles present in the atmosphere.

The information provided by these studies is needed by the Board to carry out its statutory role of controlling air pollutant emissions from motor vehicles, to address the intense public concern about diesel soot emissions, and to achieve and maintain the federal and state ambient air quality standards. Because air quality in California violates certain air quality standards by a wide margin, more timely and stringent control measures may be required, as compared to the balance of the nation. Without the unique

A. EMISSIONS FROM DIESEL-POWERED VEHICLES

RESEARCH GOALS & OBJECTIVES	CURRENT RESEARCH TOPICS FY 84-85	PLANNED RESEARCH TOPICS FY 85-86	FY 86-87
Health effects assessment	-investigate effects of acidity on the lung using simulated urban atmospheres	-continuing	-continuing
		-absorption and excretion of mutagens and carcinogens from heavy duty diesel particulate matter	-repeat using PM from LD diesel and gasoline-powered vehicles
Characterize HDV and LDV emissions	-select analytical techniques, begin determining emissions factors	-complete emissions factor determination	-compile emissions data, assess trends
Evaluate and demonstrate HDV and LDV emission controls	-characterize and evaluate LDV emission controls	-set up and operate test vehicles	-analyze and report results of test vehicles
	-characterize and evaluate HDV emission controls	-set up and operate test vehicles	-analyze and report results of test vehicles
	-evaluate soot traps, engine modifications and alternative fuels (year 1 of 2)	-evaluate traps, etc. (year 2 of 2)	
		-identify toxic and mutagenic materials emitted from controlled diesel-powered vehicles	
	-heavy duty engine rebuilding practices		
		-evaluate effects of changes to diesel fuel composition	
		-evaluate transfer of control technology to off-road vehicles	
Develop diesel Motor Vehicle Inspection Program (HDV and LDV) (high priority)	-preliminary studies in support of diesel MVIP, pilot program	-continuing support studies, begin pilot program	-preliminary review of effectiveness of diesel MVIP
Characterize diesel-emitted particles in the atmosphere	-identify toxic and emitted mutagenic materials from diesel-powered vehicles (year 1 of 2)	-toxic materials from diesels (year 2 of 2)	

B. TOXIC AIR CONTAMINANTS

Assembly Bill No. 1807 (Tanner) defined toxic air contaminants as air pollutants which may cause or contribute to increased mortality or serious illness or pose a present or potential health threat. The Bill also established a two-phase program to address each toxic air contaminant; substances are first identified, then a control decision is made. Finally, the Bill established a Scientific Review Panel to review the information assembled by the staffs of the Department of Health Services and the Air Resources Board and make recommendations to the Board. The ARB has responsibilities in all aspects of the program. After completing the substance identification phase (risk assessment), in cooperation with the Department of Health Services, ARB is responsible for the control decision phase (risk management). In responding to this new legislative mandate, the Board has assigned the highest priority to fulfilling its responsibilities for the identification and control of toxic air contaminants in the state.

Following the prioritization criteria established in Assembly Bill 1807 (which include: risk of harm to public health; amount or potential amount of emissions; manner of usage; persistence in the atmosphere; and ambient concentrations), and information developed by the International Association for Research on Cancer, the staff of the ARB identified compounds of significant concern in California and compounds of potential concern in California. Currently, the ARB staff is proceeding with the AB 1807 process on the list of compounds of significant concern. A research project initiated in FY 1983-84 is investigating sampling and analytical methods for some of the compounds on this list.

The Board's three-year research plan identifies research needed to augment and complement the work of ARB staff in carrying out the Board's mandate relative to toxic air contaminants. The plan outlines a coordinated research program to fill both short-term and

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long-term needs for information on toxic air contaminants. Short-term research needs include information required to begin the AB 1807 process for the compounds of significant concern. Specifically, in 1984-85, staff proposes to initiate research projects to investigate the sources, emissions, atmospheric concentrations and fate in the atmosphere of chloroform and specific sources for vinyl chloride. Both of these toxic compounds are found in the atmosphere at unexpectedly large concentrations compared to the emissions from known sources.

The long-term plans for toxic substance research are oriented toward the toxic compounds of potential concern, including products of incomplete combustion. Future research projects will: survey and quantify toxic emissions from major sources; examine the formation and fate of such substances in the atmosphere and in controlled atmospheres; characterize source-receptor relationships; and study the retention and metabolism of inhaled toxic substances. The information to be provided by these studies is needed by the staff and Board to complete the risk assessment portion of the AB 1807 process for control of toxic air contaminants.

B. TOXIC AIR CONTAMINANTS

RESEARCH GOALS & OBJECTIVES	CURRENT RESEARCH TOPICS FY 84-85	PLANNED RESEARCH TOPICS FY 85-86	FY 86-87
Health assessment	-evaluate retention of inhaled toxic pollutants	-evaluate the possible role of particles as carriers of toxic compounds	-human retention studies at ambient levels
Identify toxic compounds of concern	-identification of toxic compounds	-continuing	-continuing
Quantify toxic compound emissions for significant sources of priority toxic compounds	-survey and quantify significant sources of priority toxic air contaminants (e.g. chloroform and vinyl chloride)	-continuing, other compounds of potential concern and products of imcomplete combustion	-continuing
Develop and assess methods to reduce emissions of toxic air contaminants	-develop a methodology to assess costs and benefits of reducing toxic compound emissions (risk management)	-apply methodology to evaluate specific toxic substance controls	-continuing
Characterize atmospheric concentrations of toxic air contaminants	-develop improved methodologies for analyzing classes of toxic air pollutants (in progress)	-develop improved methodologies for analyzing selected toxic air pollutants	-continuing
Characterize atmospheric transformations for selected toxic air contaminants	-characterize atmospheric transformations resulting in formation and/or destruction of selected toxic and/or mutagenic compounds (in progress)	-continuing	-continuing
Characterize source-receptor relationships for priority toxic compound emission sources	-transport studies to determine source-receptor relationships for significant sources of priority toxic and/or mutagenic compounds	-continuing	-continuing
Investigate effects of particle deposition and toxicity	-investigate absorption characteristics and effects on deep lung cells	-continuing	-continuing

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Quantify toxic compound emissions for significant sources of priority toxic compounds	-survey and quantify significant sources of priority toxic air contaminants (e.g. chloroform and vinyl chloride)	-continuing, other compounds of potential concern and products of imcomplete combustion	-continuing
Develop and assess methods to reduce emissions of toxic air contaminants	-develop a methodology to assess costs and benefits of reducing toxic compound emissions (risk management)	-apply methodology to evaluate specific toxic substance controls	-continuing
Characterize atmospheric concentrations of toxic air contaminants	-develop improved methodologies for analyzing classes of toxic air pollutants (in progress)	-develop improved methodologies for analyzing selected toxic air pollutants	-continuing
Characterize atmospheric transformations for selected toxic air contaminants	-characterize atmospheric transformations resulting in formation and/or destruction of selected toxic and/or mutagenic compounds (in progress)	-continuing	-continuing
Characterize source-receptor relationships for priority toxic compound emission sources	-transport studies to determine source-receptor relationships for significant sources of priority toxic and/or mutagenic compounds	-continuing	-continuing
Investigate effects of particle deposition and toxicity	-investigate absorption characteristics and effects on deep lung cells	-continuing	-continuing

C. AIR POLLUTION DAMAGE TO AGRICULTURAL CROPS AND FORESTS

Air pollution damage to crops in California may exceed one billion dollars per year. In addition, air pollution injures forests and other native vegetation. The ARB has placed a high priority on investigating the effects of this air pollution injury on agriculture and native vegetation in California, its specific causes, and its associated economic impacts.

The Board's mandate to limit crop damage due to air pollution arises from the Board's explicit statutory responsibility to adopt ambient air quality standards in consideration of public welfare. Any such standard must be scientifically sound and technically defensible. In the absence of a coordinated research effort to assess crop damage induced by air pollution, it is unlikely that damage estimates used in standard setting can be made sufficiently accurate and reliable to avoid significant errors in the resulting pollution control policy. Depending upon the regulatory approach used, substantial undercontrol or overcontrol of pollutant levels may ensue, resulting in undue economic costs, either to California agriculture and consumers, or to the owners and operators of emissions sources. The coordinated research program proposed herein, in concert with the ongoing crop loss assessment program, is designed to provide the needed information to develop, implement and support economically efficient air pollution management strategies. The proposed three-year plan for vegetation effects research addresses both biological and economic impacts of air pollution on crops. Biological effects will be examined through two types of studies. The first type of study is of yield loss and is conducted in open-top chambers. This type of study has been a major element of the research program to date. Planned efforts will focus on economically important perennial crops such as grapes and citrus. The second type of biological study focuses on understanding processes by which yield losses occur, and factors which can modify plant response to air pollution. In these studies, researchers will

examine physiological response mechanisms, and environmental and cultural factors such as humidity, light, fertilization and irrigation. These studies are intended to develop information, applicable to most plants, about measurable physiological changes that can indicate future yield losses, and about how local growing conditions can be taken into account in using the yield loss information from field chamber experiments. This type of information is essential to the success of the new crop loss assessment program.

Economic impacts of air pollution on vegetation will be addressed through studies to improve methods of crop loss assessment, studies which apply these improved methods, and studies to determine air pollution emissions sources which adversely affect California's major agricultural regions. The results of these economic assessment and source determination studies will be integrated with the results of the studies on the biological aspects of air pollution to develop economically efficient strategies for mitigating crop losses due to air pollution.

The proposed plan also includes an expanded effort to increase public awareness of air pollution damage to vegetation, as suggested by the Board's Agricultural Advisory Committee. This plan is to set up demonstrations of healthy and air-pollution injured plants side-by-side. The demonstration would be readily accessible to the public and would provide a first-hand look at the plant damage that can result from elevated air pollution levels.

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C. AIR POLLUTION DAMAGE TO AGRICULTURAL CROPS AND FORESTS

RESEARCH GOALS & OBJECTIVES	CURRENT RESEARCH TOPICS FY 84-85	PLANNED RESEARCH TOPICS FY 85-86	PLANNED RESEARCH TOPICS FY 86-87
Assess effects of air pollution on plants under controlled conditions	-maintain ARB fumigation facility at UCR (in progress)	-continuing	-continuing
	-determine effect of O_3 and SO_2 on citrus (in progress)	-continuing	
	-determine effect of O_3 and SO_2 on grapes (in progress)	-continuing	
	-determine effect of O_3 and SO_2 on growth and yield of field crops		
		-assess O_3 and SO_2 effects on native vegetation	-continuing
Assess effects of air pollution on intrinsic plant factors and their influence on plant response (physiology, growth stage)	-identify sensitive early indicators of plant damage by air pollution		
		-assess premature plant tissue aging caused by O_3 and SO_2	-continuing
		-assess plant response to O_3 and SO_2 at different growth stages	-continuing
Assess influence of extrinsic factors on plant responses to air pollution (humidity soil, irrigation, fertilization, etc.)		-determine effects of O_3 and SO_2 on plants as influenced by humidity, soil salinity, fertilizer, light, irrigation, etc.	-continuing
Disseminate scientific information to promote public awareness of air pollution damage to plants		-set up and conduct demonstrations showing healthy and air pollution-damaged plants	
Improve methodologies for measuring and evaluating damage to specific crops, range plants and forest vegetation	-investigate statistical methods of estimating crop loss functions (in progress)	-evaluation of agricultural economic models	
	-develop and apply methods to measure and evaluate damage to forest in southern California (year 1 of 2)	-forest damage (year 2 of 2)	
Assess crop damage and determine emission sources affecting major farming regions of California			
a. San Joaquin Valley	-perform crop damage assessment at the farm level (in progress)	-continuing	-continuing
	-use input/output analysis to determine indirect economic losses associated with crop damage		
	-determine aerometric data needs and plan field study to determine sources of air pollution that cause crop damage in the SJV (year 2 of 5)	-begin intensive field study (year 3 of 5)	-intensive field study and start of data analysis (year 4 of 5)
b. Other agricultural regions	-obtain disaggregated crop yield data for damage assessment (year 1 of 5)	-perform crop damage assessment for one or more major farming regions; plan field study to determine emission sources of air pollution that cause crop damage (year 2 of 5)	-continuing (year 3 of 5)

D. HEALTH EFFECTS AND AIR QUALITY STANDARDS REVIEW

The ARB has a major responsibility to protect the health of the people of California from the harmful effects of air pollution. These concerns guide most of the Board's research on the adverse effects of air pollution on human health. There are six major problem areas and lines of research which will be addressed in the next three years.

1. Particles and Their Associated Toxicity. The Board has placed a high priority on research on the effects of suspended particulate matter in order to furnish data for review of the ambient air quality standard for respirable particulate matter (PM_{10}). The Board continues to have a concern that the California standard for PM_{10} is some three to seven times below a proposed federal standard. The ARB's reliance on quantitative epidemiological data from London requires close scrutiny. Indirect tests of the evidence appear to be most fruitful. Therefore, research will investigate how particles are absorbed, as well as their specific effects on deep lung cells, because the deep lung is most sensitive and susceptible to damage by particles. Studies are underway and are expected to continue over the next two years in order to provide information on how soots and acidic atmospheres interact to affect lung injury. These efforts may provide a clearer basis for assessing how particle-laden atmospheres impact health.

2. Effects of Gaseous Criteria Pollutants. Air quality standards are scheduled for regulatory review by the Board every five years, and studies are planned to provide essential information needed for these reviews. Three gaseous pollutant standards have been identified as needing specific new data for their next review: a) NO_2 - the evidentiary bases for both the current short- and long-term ambient air quality standards are in need of clarification and new data. Recent descriptions of

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responsiveness of asthmatic subjects to brief NO_2 exposures requires further investigation and confirmation. NO_2 is also suspected of causing long-term effects on lung function and the general health status of a broad range of individuals.
b) CO - an especially urgent problem because the scientific bases for current standards have been challenged. Exposure efforts are underway which may point to specific knowledge needs. c) H_2S - questions regarding community exposure levels and perception of this pollutant. In addition to these pollutants there is a need to study the effects of various combined gaseous pollutants.

3. Long-term Exposure to Ambient Air Pollution. Air quality standards have been set to protect sensitive groups in the population. However, most of our air quality standards are short-term standards because most of our knowledge of health effects has been of short-term effects. Exposure to air pollution that occurs over a lifetime probably produces effects quite different from those seen in acute exposures. Long-term effects of photochemical air pollution (smog) have been difficult to assess and present a major gap in our knowledge. The proposed studies would continue previous epidemiological and derived studies which have identified groups of people who appear to have reduced lung function due to breathing community air. These studies will enhance knowledge about long-term effects on sensitive groups and aid in the Board's risk assessment activities.

4. Effects on Susceptible Groups. Air quality standards are set at levels which protect the most sensitive groups of the population. Not only are members of these groups more sensitive but they can be considered to present "early warning signals" of conditions that may affect the rest of the population. In order to constantly evaluate the appropriateness of our standards, continued research on these sensitive groups is needed, using

more sophisticated methods. The program is designed to study effects of pollutants, combinations of pollutants, and community air on three sensitive groups - asthmatics, children and sensitive groups identified in previous epidemiology studies.

5. Development of New Analytical Techniques to Evaluate Effects. The expense of doing biological research and the difficulty of obtaining precise, unambiguous results make a strong case for investing in improved research methods. Therefore, to provide the most accurate and reliable estimation of health effects, a review of more reliable laboratory and statistical techniques for evaluation of effects will be conducted and applied first to animals and then to humans.

6. Economic Cost of Health Damage. The costs of meeting various air quality standards or emission regulations can often be calculated by available methods. However, the need for estimating the monetary value of pollution damage, which often arises when the Board makes policy decisions concerning pollution effects, is much more difficult to meet. Accordingly, several research projects are planned to develop and employ new methods of estimating the benefits of control. A study is underway to estimate one facet of such control benefits, avoidance of asthma attacks caused by air pollution. A subsequent project will use the results of chamber studies to estimate the cost of ambient exposures.

Taken together, the above topics comprise a coordinated research program which is intended to meet the Board's short-term and long-term needs for information on health effects of air pollutants.

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Taken together, the above topics comprise a coordinated research program which is intended to meet the Board's short-term and long-term needs for information on health effects of air pollutants.

D. HEALTH EFFECTS AND AIR QUALITY STANDARDS REVIEW

RESEARCH GOALS & OBJECTIVES	CURRENT RESEARCH TOPICS FY 84-85	PLANNED RESEARCH TOPICS FY 85-86	PLANNED RESEARCH TOPICS FY 86-87
Assess health effects of criteria pollutants	-assess effects of H_2S at ambient levels	-assess physiological and neurological effects of carbon monoxide	-continuing
			-investigate short-term effects of nitrogen dioxide
			-perform epidemiology studies on long-term effects of NO_2
Long-term exposure to ambient air pollution	-determine effects of animal exposure to ambient air pollution	-continuing	-continuing
	-perform follow-up epidemiology study on established groups	-initiate new epidemiology studies on effects using established study groups	-continuing
Determine effects of air pollution on susceptible groups	-perform laboratory testing of effects of pollutant combinations on lung functions of asthmatics	-continuing	-continuing
		-field study on effects of ambient air pollution on children	-continuing
			-perform combination studies of NO_2 and O_3 effects on sensitive groups
		-continue investigation of air pollutant and exercise interactions	
Develop novel indicators to evaluate human health effects of air pollutants	-review techniques available to detect cell and tissue loss	-apply techniques to animal models	-apply techniques to humans
	-analyze daily illness and mortality in the South Coast Air Basin		
Estimate costs of California's air pollution-caused health effects	-measure expenditures and changes in behavior resulting from air pollution-induced asthma attacks (in progress)	-relate health impacts measured in controlled laboratory studies to health effects that can be assigned dollar values	-continuing

E. REGIONAL AIR POLLUTION STUDIES

Ozone, inhalable particles (PM_{10}) and other secondary pollutants which are formed in the atmosphere from gaseous pollutant precursors are major contributors to known air pollution health and property damage, particularly in the South Coast Air Basin, and they are major contributors to air pollution-caused crop damage in the San Joaquin Valley Air Basin. Major gaps exist in our knowledge and ability to manage these secondary pollutants due to the complexity of atmospheric chemistry and photochemistry and the limited capability in state-of-the-art of current air quality simulation models that are used to relate precursor emissions and secondary pollutant concentrations.

The plan addresses the beginning of at least a five-year project designed to provide significantly improved air quality prediction capability for ozone and soundly-based prediction capability (none now exist) for PM_{10} in the major air basins in the state. Ambient air quality standards for both of these pollutants are now violated, particularly the Bay Area, South Coast, and San Joaquin Valley Air Basins. This will be accomplished by improving substantially the capabilities of available photochemical simulation models for ozone, by contributing to the development of simulation models for fine particles and PM_{10}, and by providing the necessary base of aerometric data to exercise and test both ozone and PM_{10} models in these air basins. In addition, this multi-year research plan provides for: assessment of the major pathways for transport of pollutants and precursors within and between air basins, determination of sources and precursors of atmospheric mutagenicity, and documentation of the role of nitrogen oxides (NOx) in the formation of ozone, aerosols and mutagens.

The information from this set of field and modeling studies will be used by state, local and federal agencies and by industry to improve

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E. REGIONAL AIR POLLUTION STUDIES

RESEARCH GOALS & OBJECTIVES	CURRENT RESEARCH TOPICS FY 84-85	PLANNED RESEARCH TOPICS FY 85-86	PLANNED RESEARCH TOPICS FY 86-87
Assess major pathways for transport of pollutants and precursors	-Project Basin, South Coast Air Basin upper air study (in-progress)	-San Diego-Tijuana trans-border study (year 1 of 2)	-San Diego-Tijuana study (year 2 of 2)
	-Sacramento Valley Particle Study (in-progress)		-Mexicali-Imperial trans-border study (year 1 of 2)
Determine sources and precursors of atmospheric mutagenicity	-identification of mutagenic compounds in urban atmospheres	-determination of formation mechanisms and sources of mutagens	
Document the role of NOx in the formation of ozone, aerosols and mutagens	-field, laboratory and modeling studies to document the role of NOx	-continuing	-continuing
Develop and demonstrate improved photochemical and PM_{10} models for Bay Area, South Coast and San Joaquin Valley Air Basins	-update LIRAQ model for use in Bay Area and North Central Coast Air Basins (in progress)	-continuing	
		-develop and demonstrate photochemical and PM_{10} models for SJV (year 1 of 4)	-SJV model (year 2 of 4)
	-develop and demonstrate improved photochemical and PM_{10} models for the SCAB, using data from Project BASIN and SCAB field study (year 1 of 5)	-SCAB model (year 2 of 5)	-SCAB Model (year 3 of 5)
In-depth analysis of aerometric data	-determine statistical relationships between ambient concentrations of criteria pollutants, toxics, mutagens, PM_{10} and visibility	-continuing	-continuing
		-determine the spatial and temporal distribution of mutagens in the South Coast Air Basin	
			-determine the spatial and temporal distribution of mutagens in the southern San Joaquin Valley
Develop comprehensive aerometric data base for determining sources and receptors for PM_{10} and O_3 in the SCAB	-plan field study to determine source-receptor relationships for PM_{10} and O_3 in SCAB (year 1 of 5)	-begin intensive field study (year 2 of 5)	-intensive field study (year 3 of 5)

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Determine sources and precursors of atmospheric mutagenicity	-identification of mutagenic compounds in urban atmospheres	-determination of formation mechanisms and sources of mutagens	
Document the role of NOx in the formation of ozone, aerosols and mutagens	-field, laboratory and modeling studies to document the role of NOx	-continuing	-continuing
Develop and demonstrate improved photochemical and PM_{10} models for Bay Area, South Coast and San Joaquin Valley Air Basins	-update LIRAQ model for use in Bay Area and North Central Coast Air Basins (in progress)	-continuing	
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F. REDUCING EMISSIONS FROM MOBILE AND STATIONARY SOURCES (Excluding Diesel Vehicles)

Excess emissions of criteria pollutants in major air basins in the state contribute to current violations of health and welfare-based ambient air quality standards. Local districts, as well as Board staff, have been unable to identify sufficiently effective control measures to ensure that all federal ambient air quality standards will be achieved and maintained, while accommodating further growth in California. Accordingly, the determination of emissions and the development and assessment of control technologies for specified source categories, including the assessment of alternative technologies, is a major ARB research objective.

The information provided under the proposed three-year plan will provide to the ARB, to local air pollution control districts and to others, needed information on emissions and/or potential control technology options for criteria pollutants for specified emission categories of particular importance in California. Problems of particular importance to the state are: current exceedances of state or federal ambient air quality standards; major knowledge gaps as to the source of these problems; or significant trends toward or use of selected alternatives which have the clear potential for adverse air quality effects. Potential sources that warrant investigation include: VOC emissions from solvent-borne consumer products; VOC emissions from spreading of petroleum sludges on land (land farming); VOC emissions from exempt architectural coatings; VOC and other emissions from the burning of biomass and municipal wastes in power plants; NOx and SOx emissions from selected fuel combustion operations; fine particulate emissions from agricultural burning operations; and VOC emissions from the use of alternative fuels such as methanol and ethanol.

F. REDUCING EMISSIONS FROM MOBILE AND STATIONARY SOURCES, EXCLUDING DIESELS

RESEARCH GOALS & OBJECTIVES	CURRENT RESEARCH TOPICS FY 84-85	PLANNED RESEARCH TOPICS FY 85-86	FY 86-87
Determine volatile organic carbon (VOC) emissions from selected source categories	-speciate the volatile emissions from crude oil processing operations and relate to the total vapor pressure of the oil (in progress)	-quantify VOC emissions from sumps and working tanks; determine vapor pressure for petroleum products and crudes	-continuing
	-quantify fugitive emissions from refineries and oil production operations	-quantify VOC emissions from solvent-borne consumer products	-speciate and quantify VOC emissions from toxic waste burning
	-evaluate potential to reduce emissions from graphic arts processes	-quantify VOC emissions from land farming operations	-determine the change in VOC emissions as catalysts on light-duty vehicles age in use
	-laboratory testing of exempt architectural coatings	-continuing	-continuing
Determine NOx, SOx and fine particle emissions from selected sources and develop control strategies	-develop control methods for PM_{10} emissions from blasting operations	-assess the applicability of NOx and SOx control demonstration projects to various sources in CA	-continuing
Assess emissions from agricultural burning and their mitigation	-develop test procedures for emissions from agricultural burning	-quantify (and for VOC, speciate) emissions from agricultural burning	-evaluate strategies to mitigate emissions from agricultural burning
		-determine emissions and air quality impacts of burning agricultural waste and biomass products in power plants	-determine emissions from the production of fuels from biomass
Assess air pollution effects of alternative fuels	-assess atmospheric impacts of substituting alcohol-based for petroleum-based fuels in motor vehicles, effects on multi-day episodes (high priority-in progress)	-continuing	-continuing
Improve analyses of the economic impacts of air pollution and abatement strategies	-evaluate the impact of regulating toxic substances on the processors of food and fiber	-develop and apply microeconomic models to evaluate the impacts of regulations	-continuing
Improve economic bases for emission inventory estimates	-improve methods for disaggregating statewide economic forecasts into emission inventory-compatible industrial categories		
Assess impacts of and alternatives to permit regulations for new sources		-survey problems associated with permitting new sources and identify emission reductions available as offsets	-evaluate alternate methods to offsets required by local district regulations
Assess effects of selected on going control programs		-assess benefits of motor vehicle inspection program for LDV	
Assess relationships between indoor and outdoor air quality			-pilot study to relate indoor and outdoor air quality

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	-evaluate potential to reduce emissions from graphic arts processes	-quantify VOC emissions from land farming operations	-determine the change in VOC emissions as catalysts on light-duty vehicles age in use
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III. SUMMARY

The three-year reseach plan that is outlined in Chapter II describes the information needed over the next two to five years and the ARB's affirmative approach to obtaining this information. If these knowledge gaps are not addressed in an effective manner the Board will be unable to continue making significant progress toward attainment and maintenance of health and welfare-based ambient air quality standards, while accommodating substantial economic growth in the state.

CHAPTER 4. RESEARCH

39700. The Legislature hereby declares that an effective research program is an integral part of any broad-based statewide effort to combat air pollution.

39701. The state board shall coordinate and collect research data on air pollution, including, but not limited to, all of the following:

(a) Research relating to specific problems in the following areas:

(1) Motor vehicle emissions control, including alternative propulsion systems, cleaner burning fuels, and improved motor vehicle pollution control devices.

(2) Control of nonvehicular emissions.

(3) Control of specific contaminants to meet ambient air quality standards.

(4) Atmospheric chemistry and physics.

(5) Effects of air pollution on human health and comfort, plants and animals, and reduction in visibility.

(6) Instrumentation development.

(7) Economic and ecological analysis.

(8) Mathematical model development.

(9) Trends in atmospheric quality throughout the state.

(10) Alternatives to agricultural burning.

(b) The consequences of various alternative solutions to specific air pollution problems.

(c) The identification of knowledge gaps.

39702. The state board shall report to the Legislature whenever it deems necessary to provide information on problems relating to air quality management.

39703. The state board shall administer and coordinate all air pollution research funded, in whole or in part, with state funds and, in discharging its responsibilities, the state board shall have the following duties and powers:

(a) Establish applied research objectives.

(b) Receive and review all air pollution research proposals.

(c) Recommend the initiation of specific air pollution research projects.

(d) Award contracts for air pollution research projects.

(e) Submit a detailed report to the Legislature by January 10th each year on the conduct of the air pollution research program conducted pursuant to this section.

(f) Establish the administrative and review procedures necessary to carry out the provisions of this section.

(g) Collect, validate, and disseminate educational information relating to air pollution.

39704. In awarding contracts for the conduct of air pollution research, the state board shall consider the capability of the University of California to mount a comprehensive program of research to seek solutions to air pollution problems and the ability of the university, through its several campuses, to mobilize a comprehensive research program for this purpose.

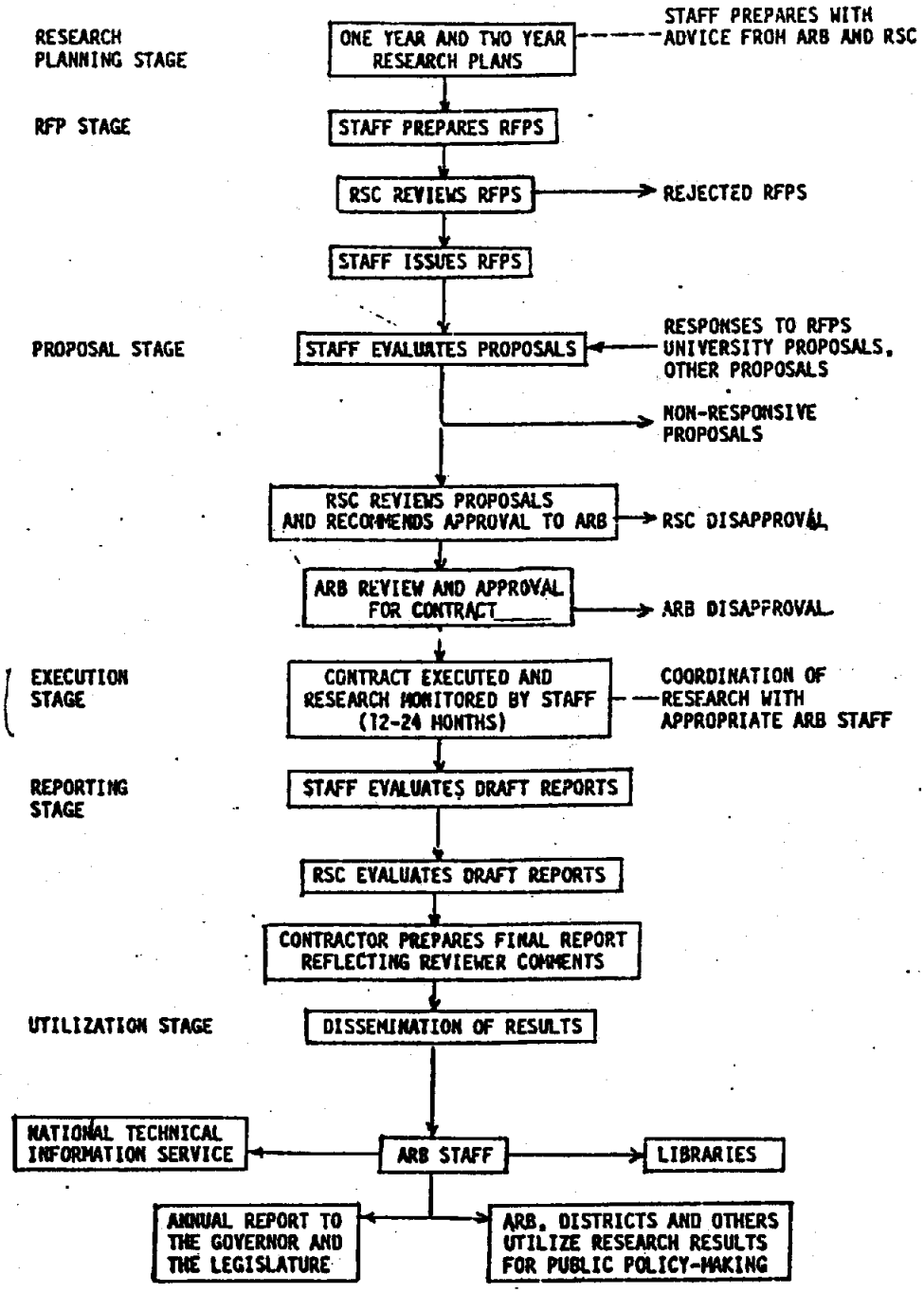
39705. The state board shall appoint a screening committee of not to exceed nine persons, the membership of which may be rotated as determined by the state board.

The committee shall consist of physicians, scientists, biologists, chemists, engineers, meteorologists, and other persons who are knowledgeable, technically qualified, and experienced in air pollution problems for which projects are being reviewed. The committee shall review, and give its advice and recommendations with respect to, all air pollution research projects funded by the state, including both those conducted by the state board and those conducted under contract with the state board.

The committee members shall receive fifty dollars ($50) per day for each day they meet to perform their duties under this section. In addition to such compensation, they shall receive their actual and necessary expenses incurred while performing such duties.

39706. The fees deposited in the Air Pollution Control Fund pursuant to Section 41853.5 are hereby continuously appropriated to the state board for research and development of a cotton gin trash incinerator heat exchanger or other device for the disposal of solid waste which is produced from the ginning of cotton, consistent with emission standards set by a district board or the state board. The state board shall consult with the Solid Waste Management Board prior to awarding a contract for, or conducting, such research and development. If the state board determines that such a device is available or that further expenditures for such purposes would not contribute meaningfully to their development, the fees shall be utilized in accordance with the provisions of Section 43014.

AIR RESOURCES BOARD
EXTRAMURAL RESEARCH PROGRAM
RESEARCH PROJECT FLOW CHART



RSC - RESEARCH SCREENING COMMITTEE
RFP - REQUEST FOR PROPOSALS

STATE OF CALIFORNIA GEORGE DEUKMEJIAN, Governor

AIR RESOURCES BOARD
1102 Q STREET
P.O. BOX 2815
SACRAMENTO, CA 95812

(916) 621-1519

November 7, 1984

Mr. Gordon Duffy, Chairman
California Air Resources Board
P.O. Box 2815
Sacramento, CA 95812

Dear Mr. Duffy:

The Board's Research Screening Committee has reviewed the proposed long range research plan and recommends its adoption by the Air Resources Board.

The Committee received the plan in August and has had it under review since that time. We spent more than two hours discussing it at our October 4 meeting and suggested several changes to staff, which they have incorporated into the proposed plan.

The long range research plan has been designed to emphasize those areas of research whose importance the Board stressed at the March 22, 1984 joint meeting of the Board and the Research Screening Committee. Staff and the Committee believe that carrying out the proposed work on the proposed time scale will require an augmentation of the research budget. However, in view of the sense of urgency expressed by the Board, especially with respect to such critical areas as toxic air contaminants and diesel particulate matter, an augmentation would appear to be justified.

The Committee has asked me to communicate its views on the long-range plan on their behalf. Should you wish, I would be pleased to appear before the Board at your meeting later this month and respond to any questions you or the members of the Board may have regarding our recommendation.

Sincerely yours,

Original Signed By

Clarence Collier, M.D.
Chairman, Research Screening Committee

cc: James D. Boyd
Executive Officer