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**RESEARCH
IN THE
ARKANSAS
HIGHWAY
DEPARTMENT**

**ARKANSAS STATE HIGHWAY DEPARTMENT
DIVISION OF PLANNING AND RESEARCH
IN COÖPERATION WITH THE
UNITED STATES DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS**

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Reviewed and Approved
by the
Highway Research Committee

SUMMARY

This study of research has been made to enable the Highway Department to have a clearer understanding of the nature and methods of highway research and especially to develop a definition of highway research that would apply specifically to the Arkansas State Highway Department.

A definition of highway research was arrived at by studying the five primary functions of the Highway Department and by examining previously accepted definitions in an effort to determine the current status of research in the routine operations of the Department.

The basic elements of research were examined along with the organizations used by other state highway departments to incorporate these into their routine functions.

The more pertinent findings and conclusions were:

1. Elements of research currently appear in the basic functions of the Highway Department but not to the degree that highway research can be presently considered either as a separate function of the Department or as an essential part of any of the basic functions.
2. The importance of highway research has been recognized and encouraged in the past by the Department's participation in the research activities of national highway organizations and by the establishment of a Joint Highway Research Program with the University of Arkansas.
3. Four types of research were identified, with the classification being based on the underlying purpose for conducting the research. These types are -- basic or pure; applied or practical; development; and operations research.
4. The general highway research needs of each of the basic functions of the Highway Department were identified and correlated with the four elemental types of research. This correlation indicated that each of the four types of research will be used to satisfy highway research needs but that applied research will be of more immediate value than will basic research.
5. A definition of research was determined that would include the Highway Department's current definition, encompass the four elemental types of research, and provide for the accomplishment of the broad research needs of the Department. This definition is:

"Research shall be limited to exploratory studies, investigations, examinations, and experimentations intended to secure and analyze, under scientific method, physical and/or abstract data; which can be used to delineate substantive facts and definitive information that can enlarge and refine understanding of the governing principles and promote the science of highway engineering, economics, and use; primarily for practical application and use in providing the most sound, efficient, and economical investment of the public monies available for the statutory function of the State Highway Commission."

6. The "scientific method" was found to be the underlying concept in all research endeavors, and five basic elements of this method of investigation were identified.
7. There are four types of research organizations used by highway departments to control their research activities. The type and number of highway departments utilizing the type in 1953 are:

Type	No. of Highway Departments
Noncentralized	30
Centrally Coordinated	5
Formal	10
Joint	<u>6</u>
	51

8. Each of the four types of organization was found to have certain inherent advantages and disadvantages; however, a just evaluation of the types could not be made without knowing how and why the individual states adopted their particular type. It was also shown that an organization could be developed separate from the specific aims of the organization.

RECOMMENDATIONS

Analysis and study of the data led to the following recommendations concerning research in the Arkansas Highway Department. It is realized that this research endeavor may be exceeding its bounds by recommending administrative policy in regard to research, but it does so only to be practical and with the clear understanding that the proposal of administrative policy is usually not the responsibility of the researcher. It was recommended:

1. That the Highway Department accept the definition of highway research as presented herein as a guide to the continued development of a comprehensive and organized highway research program;
2. That the Highway Department create a highway research advisory committee to guide the continuing program and that the

committee be organized and function in accordance with the general research criteria presented in this report;

3. That the Research Section of the Planning and Research Division be given the responsibility of administering, conducting, and reporting on research projects under the guidance and supervision of the proposed highway research advisory committee;
4. And that the advisory committee and the Research Section be charged with the preparation of detailed criteria to govern the composition and duties of the committee and the methods of administering, conducting, and reporting on research projects under their control.



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RESEARCH IN THE ARKANSAS STATE HIGHWAY DEPARTMENT

I. INTRODUCTION

Research, according to its more universal meaning -

“Studious inquiry or examination; specifically and usually, critical and exhaustive investigation or experimentation having for its aim the discovery of new facts and their correct interpretation, the revision of accepted conclusions, theories, or laws, in the light of newly discovered facts, or the practical applications of such new or revised conclusions.” 1/

- has always been present in the Arkansas State Highway Department but on a more or less informal basis. However, only in very recent times has it become apparent that research is a vital element of the Highway Department and that cognizance of this importance, on the past uncontrolled and uncoordinated basis, is not sufficient to insure the discovery of new highway facts and their correct interpretation and application.

The difficulty of conducting proper research results largely from the recent rapid advances experienced in the field of highway technology, which has greatly increased the number of new facts to be interpreted; and from the broadening of the interests of highway transportation, which has created a need for studious inquiry into previously neglected areas, such as highway economy, traffic operations, and transportation planning. These highway innovations have not only increased the volume of needed research activity but, due to their complex nature and interrelationships, have exceeded the bounds of the experience and proper understanding of many highway administrators. Thus, even though these administrators realize that the innovations must be researched and that old highway conclusions, theories, and laws must be examined in the light of these innovations, they also realize that they will not be able to properly do so without a well-regulated program expressly tailored to conduct research. Accordingly, the Engineer of Planning and Research for the Arkansas State Highway Department has been directed to create, organize, and staff a research section within his Division that will control, coordinate, and conduct highway research pertinent to the interests of the Highway Department and, by extension, to the transportation desires and needs of the public.

PURPOSE OF THIS STUDY

Highway research in the Arkansas State Highway Department has now reached a position that has certain inherent advantages. It is in a position to look back upon not only its own past activities but also the previous endeavors of other highway departments and public agencies that have a history of conducting highway research. As it pauses to re-examine its goals and reorganize its efforts, to take its proper place in the future of the Highway Department, there is a unique opportunity to draw on a wealth of experience that, if properly evaluated and

utilized, will enable research to be rapidly and successfully organized, to assume its rightful responsibilities.

Research can only "pull itself up by its own bootstraps" by studious examination of its past, by selecting from the pool of empirical knowledge those elements that will be conducive to the achievement of its future goals, and by forming new concepts and methods that experience reveals a need for. It then is the purpose of this study to conduct an examination of our, and other highway agencies', experience with research and to determine the future aims, methods, and organization for research within the Arkansas State Highway Department.

SCOPE OF THIS STUDY

To delineate the bounds of this "research of research," the above general purpose has been transposed into a set of specific guides that determine the scope of this study. These are:

- (1) To define the word "research" and spell out its many ramifications and connotations as they apply to the Arkansas State Highway Department;
- (2) To study and analyze the past and current highway research activities of the Arkansas State Highway Department;
- (3) To determine the general research needs, desires, and capabilities of the Arkansas State Highway Department and to interpret the conclusions drawn from items (1) and (2) above in the light of these needs, desires, and capabilities;
- (4) To formulate broad research methods and procedures that will serve as guides for the conduct of future research projects;
- (5) To study and analyze the past and current highway research activities of other state highway departments and of the Bureau of Public Roads; and
- (6) To devise a research organization, based on an analysis of the past and present research efforts, but predicated on the efficient and effective accomplishment of future highway research needs, by controlling and coordinating the application of the criteria governing research methods.

AUTHORITY TO CONDUCT RESEARCH

Before proceeding into the main body of this report, it is necessary to briefly consider the statutory authority and administrative policy authorizing the conduct of research in the Highway Department.

Premissive authority and delegated responsibility at the Federal level is derived from Federal highway laws as set out in Title 23, U.S. Code, and promulgated by regulations prepared by the Bureau of Public Roads, Department of Commerce. At the State level, these laws and

regulations are incorporated by reference in State Highway laws as set out in Title 76, Ark. Stats. (1947). These State laws are effectuated, in regard to State Highways, by the State Highway Commission and its administrative agent, the State Highway Department.

The State Highway Department's authority to do highway research is thus essentially rooted in Title 23, U.S. Code; and because of this, Section 307 of the Federal law which pertains to research is presented here in its entirety:

Section 307, Title 23, U.S. Code

307. RESEARCH AND PLANNING

“(a) The Secretary is authorized in his discretion to engage in research on all phases of highway construction, modernization, development, design, maintenance, safety, financing, and traffic conditions, including the effect thereon of State laws and is authorized to test, develop, or assist in the testing and developing of any material, invention, patented article, or process. The Secretary may publish the results of such research. The secretary may carry out the authority granted hereby, either independently, or in cooperation with any other branch of the Government, State agency, authority, association, institution, corporation (profit or nonprofit), or any other organization, or person. The funds required to carry out the provisions of this subsection shall be taken out of the administrative and research funds authorized by section 104 of this title and such funds as may be deposited in a special account with the Secretary of the Treasury for such purposes by any cooperating organization or person. The provisions of section 3709 of the Revised Statutes, as amended (41 U.S.C. 5), shall not be applicable to contracts or agreements made under the authority of this subsection.

(b) The Secretary shall include in the highway research program herein authorized studies of economic highway geometrics, structures, and desirable weight and size standards for vehicles using the public highways and of the feasibility of uniformity in State regulations with respect to such standards and he shall report from time to time to the Committees on Public Works of the Senate and of the House of Representatives on the progress and findings with respect to such studies.

(c) Not to exceed 1% per centum of the sums apportioned for any year to any State under section 104 of this title shall be available for expenditure upon request of the State highway department, with the approval of the secretary, with or without State funds, for engineering and economic surveys and investigations, for the planning of future highway programs and the financing thereof, for studies of the economy, safety, and convenience of highway usage and the desirable regulation and equitable taxation thereof, and for research necessary in connection with the planning, design, construction, and maintenance of highways and highway systems, and the regulation and taxation of their use.’’

At the present time, the only Bureau of Public Roads, Department of Commerce, regulations interpreting this section of the Federal law have to do with accounting for planning and research funds and to the methods of submitting research projects for approval. No regulation or policy has been established in regard to the areas of research which may be included in the Highway Planning Survey Program, except that specified in the above section of the Federal Statutes.

The Arkansas Statutes pertaining to State Highways by implication incorporate the provisions of Title 23 of the U.S. Code in their assignment of authority and responsibility to the State Highway Commission, as shown by the following excerpt from Ark. Stats. (1947) 76-201.5:

“(c) To comply fully with the provisions of the present or future federal aid acts. The Commission may enter into all contracts or agreements with the United States Government relating to the survey, construction, improvement, and maintenance of roads under the provisions of any present or future congressional enactment; may submit such scheme or program for construction or maintenance as may be required by the Bureau of Public Roads, Department of Commerce or otherwise provided by federal acts, and may do all other things necessary and proper to carry out fully the co-operation contemplated and provided for by present or future acts of Congress for the construction, improvement and maintenance of roads in rural or urban areas.”

This same Statute further states that the State Highway Commission is vested with other powers and duties that may be applied to research, as follows:

“(d) To establish a program of current and long-range planning for the State Highway System.

(e) To establish highway policies and administrative practices for the guidance and direction of the Director.

(g) To investigate highway conditions and official conduct of departmental personnel.

(h) To gather and tabulate information and statistics on road building, maintenance, and improvements and to disseminate the same through the state through appropriate channels.

(j) To adopt rules and regulations to implement its powers.”

It is thus apparent that the State Highway Commission has ample power and, in fact, has been assigned responsibility to conduct highway research either through cooperation with the Bureau of Public Roads, and financed fully or partially by Highway Planning Survey funds, or without the cooperation of the Bureau of Public Roads and financed solely by Highway Department funds.

The State Highway Commission has, in the past, acted within its authority and discharged, to a limited extent, its responsibility toward highway research by acting favorably on research matters presented to it by the State Highway Department. For example, the commission has approved participation by the Highway Department in the Joint Highway Research Projects, involving the College of Civil Engineering of the University of Arkansas and the Bureau of Public Roads. It has encouraged the Department to participate in the Highway Research Board and the Highway Research Correlation Service; it has approved of the Highway Department's financial participation in the new American Association of State Highway Officials' highway research program; and it has authorized the Department to create a research section. However, the Commission has not assigned a definite research responsibility to the Highway Department nor has it defined or delimited

the area of highway research in which its agent, the Highway Department, must operate.

But it is evident that the Highway Department does have sufficient authority to engage in highway research, through the utilization of its own personnel or personnel outside the Department through the use of its own equipment or equipment owned by others, through the use of its funds or funds supplied by other agencies, and by working entirely within its own organization or in cooperation with other appropriate agencies. It must, of course, conduct its research within the bounds established by the previously cited legal Statutes and policies, but the Department has now reached the point where it must ascertain for its administrative superiors, and for itself as well, the research responsibilities it is able and willing to assume.

II. WHAT IS RESEARCH

The definition of the word "research" presented in the Introduction is universally applicable, hence broad and super-inclusive in nature. What is needed here is a meaning of the word that can be applied exclusively -- not to highway research in general, but to highway research to be conducted by the Arkansas State Highway Department. It is important, not only to the Highway Department but also to the agencies and people with which it deals, that the meaning of "research" be set out in specific terms yet be broad enough to encompass all of the highway research responsibilities of the Department.

Research normally starts with the formulation of hypotheses or definitions and delimitations of problems to be studied. It then proceeds into the collection of facts pertinent to the hypotheses, which when sorted and organized become the data upon which the research conclusions are to be based. The body of data is then analyzed in accordance with the limits of the study set forth in the definition of the problem, and conclusions are drawn relative to the proving or disproving of the research hypotheses. Inherent in research are the elements of a defined problem, collected and sorted data, methodical and controlled analysis, verified conclusions, and, most important, a purpose of developing new laws, theories, methods, and ideas that can be generally applied to the solution of problems. These elements will be examined in detail in this study and then compared to the normal activities of the Highway Department to determine where research is now included in these normal activities.

FUNCTIONS OF THE DEPARTMENT

Basically, the Highway Department is responsible for three highway functions. These are (1) design; (2) construction; and (3) maintenance of State highways. Other functions have been added to facilitate accomplishment of the basic functions, and these are (4) administration, (5) planning and (6) materials. At this time, research is not a primary function of the Highway Department even though the Department has been active in research as will be pointed out later. (The following discussion of each of the primary functions is directly based on material

contained in a paper on the organization, operation, and finance of the Arkansas State Highway Department prepared by the Department in November, 1961, and entitled "Your State Highway Department." 2/)

1. Design: The design function includes the collection and analysis of data and the drawing of conclusions which result in detailed roadway job designs, plans, and specifications for every foot of roadway and structure to be constructed. Six administrative divisions are currently performing this design work; i.e., "Bridge Design," "Surveys," "Roadway Design," "Materials and Tests," "County Program," and "Right of Way".
Routine highway design does include four of the elements of research but cannot be considered research since it lacks the fifth element -- that of conclusions leading to new ideas or methods that can be universally applied to design efforts -- hence, even though "design" uses the methods commonly assignable to research, it is not research.
2. Construction: "The Construction Division exercises staff supervision through the District Engineers over all construction activities in the State. Through this overall supervision, a uniform interpretation of contracts and specifications is assured." 2/ From this it can be seen that the function of construction, which is administered primarily by the "Construction Division" and the District Engineers in cooperation with "Office Engineer," "Materials and Tests," and County Program," is mainly one of supervising and inspecting and, as such, cannot be considered to be research.
3. Maintenance: The function of highway maintenance consists of the overall supervision and performance of work necessary to repair and maintain the highways after they are constructed. This includes roadway maintenance and bridge maintenance. Also included are the efforts needed to operate the highway system, such as signing and centerstriping, issuing special road use permits, and traffic engineering procedures. Here again, research is not a routine part of this function.
4. Administration: Administration functions to coordinate, correlate, and supervise the divisions performing the above basic functions of the Highway Department and provides auxiliary services that are "housekeeping" in nature. Inherent in "administration" are manipulation of personnel and equipment and the extension of assistance that enables the "line" divisions to properly function. It is, by nature, outside the realm of research.
5. Planning: The Highway Department has only recently given formal recognition to the function of highway planning although it has long been a part of the Highway Department's job. Primary responsibility is vested in the Planning and Research Division, whose function is "to collect and classify, analyze and interpret, then publish and disseminate factual information

relating to highways." 2/ Other duties of this Division include: long-range advanced highway programming, highway adequacy ratings, inventory of critically inadequate highway sections, economic projections for financing, economic impact studies, economic considerations of proposed highway improvements, and preliminary study of road earnings.

This is one administrative division in the Highway Department whose routine functions either closely parallel or actually are research. In this Division, the separation between routine fact-gathering and analysis and research can only be made on the individual project level. If the end result of the project is to gather facts only and does not include drawing up conclusions that may be applied to the solution of a general field of problems, it is not research. If the end result is to present substantiated information on conceptions or methods that can be used to solve a series of problems in a certain field, it can be considered research.

6. Materials: A discussion of the functions of the Highway Department and their relation to highway research cannot be completed without specifically mentioning the Division of Materials and Tests. This Division functions in the areas of both design and construction. Its main duty is to "see that the very best materials available are used in our highway building program." 2/ In performance of this duty, it investigates the extent and quality of materials, collects information on soil conditions, checks all structural and reinforcing steel used in highway and bridge construction, and makes on-the-job inspections to see that all materials meet specifications. In addition, it has been participating in a continuing program of highway research with the College of Engineering at the University of Arkansas.

Materials and Tests is the only division of the Highway Department that has been engaged in formal research in the past; however, it should be pointed out that although the Division is directly suited to conduct research, due to the scope of its operations and the equipment it uses, and has been active in research in the past, its normal function does not now include research. Its efforts toward the function of research have been extra-curricular in nature.

From the foregoing, it can be concluded that the Highway Department has not formally recognized highway research as a normal function, even though the Department has participated in some research and normally does some things that closely border on research. However, it should not be concluded that the Highway Department has not recognized the value of highway research and made efforts to incorporate it into its job. The following illustrations indicate this point:

1. Through the American Association of State Highway Officials, the Department has been a participant in the affairs of the Highway Research Board of the National Academy of Sciences - National Research Council since its inception in 1921.
2. The Department is a member of the Highway Research Correlation Service, an administrative adjunct of the Highway Research Board.
3. The Department has conducted many roadway construction experimental projects designed to reveal new construction methods through testing the performance of roadway surfaces and bases. These have not been formally reported.
4. A formal agreement has been reached with the University of Arkansas in regard to the establishment of a Joint Highway Research Program to provide for the operation of a continuing program of cooperative highway research.^{3/}
5. The Department has agreed to financially participate in the Highway Research Program initiated by the American Association of State Highway Officials in 1961.^{4/}

A definition of "what is research" can be gleaned from the preceding discussion of the functions of the Highway Department and the examples of its past research endeavors, but it should be remembered that a definition so arrived at would represent past thinking rather than a consideration of research in the future.

This summary of experience has been aptly reflected by the Joint Highway Research Program Agreement,^{3/} which was enacted in December 1956, and is cited here as the current understanding of the term "research" as accepted by the Highway Department.

"III Purpose: (A) The general purpose of the PROGRAM is to secure and analyze data and to develop facts and information which will define the governing principles and will advance the science of highway engineering for practical application in using in the most efficient and economical manner the public moneys now available for highway improvement purposes."

TYPES OF RESEARCH

Continuing with the examination of the ambiguities of the word "research," the following definitions are presented as a guide to a determination of the full range of the word as an aid in determining the scope particularly adaptable to the requirements of the Arkansas State Highway Department:

- (1) Basic or Pure Research: The National Science Foundation defines basic research to be: "Basic research is that type of research which is directed toward increase of knowledge in science. It is research where the primary aim of the investigator is a fuller knowledge or understanding of the subject under study, rather than a practical application thereof." 5/
- (2) Applied or Practical Research: "Applied research --- is a technical undertaking aimed at solving problems of practical significance in which the scope and extent of the work are determined by the degree of likelihood that it will lead to practical rewards." 6/
 "Applied Research is a search for new knowledge directly applicable to a specific problem and the application of all existing knowledge to the practical solution of the problem." 7/
- (3) Development Research: Development research may be considered as a subdivision of Applied Research. "Development Research includes such items as design, engineering and production of phototype models." 8/
- (4) Operations Research: "Operations Research is a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control." 9/

The above four definitions of research effectively describe the end results of or purposes for undertaking a research project. To properly label the particular area to which the research applies, it is only necessary to preface "research" with an adjective that describes the area; for example, "space research," "atomic research," "medical research," and so on. To define the area of interest in this report, the adjective "highway" is added, and the area of interest then becomes "highway research." The point is that the basic types of research, according to the end results, are not altered by delimiting the area of interest. Hence, "basic," "applied," "development," and "operational" may still be considered as the four elemental types of highway research.

To further delimit the term "highway research" to fit the scope of this report, it is necessary to add reference to the Arkansas State Highway Department, thus creating the term, HIGHWAY RESEARCH IN THE ARKANSAS STATE HIGHWAY DEPARTMENT. Here again, the basic concepts of "research" have not been altered by its modifiers.

RESEARCH DEFINED

In the light of the foregoing discussion on "What Is Research," it is now possible to arrive at a definition. It is thus proposed that HIGHWAY RESEARCH IN THE ARKANSAS STATE HIGHWAY DEPARTMENT be defined as follows:

RESEARCH SHALL BE LIMITED TO EXPLORATORY STUDIES, INVESTIGATIONS, EXAMINATIONS, AND EXPERIMENTATIONS INTENDED TO SECURE AND ANALYZE, UNDER SCIENTIFIC METHOD, PHYSICAL AND/OR ABSTRACT DATA WHICH CAN BE USED TO DELINEATE SUBSTANTIVE FACTS AND DEFINITIVE INFORMATION THAT CAN ENLARGE AND REFINE UNDERSTANDING OF THE GOVERNING PRINCIPLES AND PROMOTE THE SCIENCE OF HIGHWAY ENGINEERING, ECONOMICS, AND USE; PRIMARILY FOR PRACTICAL APPLICATION AND USE IN PROVIDING THE MOST SOUND, EFFICIENT, AND ECONOMICAL INVESTMENT OF THE PUBLIC MONIES AVAILABLE FOR THE STATUTORY FUNCTION OF THE STATE HIGHWAY COMMISSION.

III. RESEARCH "NEEDS"

The purpose of this section of the report is to spell out in broad terms the current highway research necessities and desires of the State Highway Department, within the frame of reference established by the definition of research. To properly do this, it is necessary to reconsider the functions for which the Department is responsible and to indicate how accomplishment of these has been influenced by the recent influx of technological innovations and by the broadening of the functional area of interest. 10/

DESIGN FUNCTION:

Previous National and Departmental highway research, which has been heavily attentive to the needs of this function, has produced a great wealth of definite information on the structural aspects of design, but recent added interest in safety and expediency of travel has created a need for more knowledge of the geometrical aspect of design. If it is realized that the first purpose of the design function is to provide a highway facility that will safely, efficiently, and expeditiously move traffic and secondarily to devise a structure, based on physical laws, that will do so in a satisfactory manner, it is readily apparent that the geometric aspects take research priority over the structural aspects; particularly since the structural aspects have been much more thoroughly researched in the past. The general needs of this function, then, are:

A. Geometric Design:

1. A greater understanding of the relationship between traffic needs and desires and the geometric aspects of highway design.
2. The determination of general geometric design policies and practices based on the above understanding.
3. The development of geometric design criteria related to the functional classification of roadways.

B. Structural Design:

1. More complete knowledge of the physical laws, and their inter-relationships, as they pertain to highway design.
2. The formulation of rational design policies based on physical laws instead of empirical knowledge.
3. The development of structural designs based on roadway function and traffic characteristics.

CONSTRUCTION FUNCTION:

Currently, the main research interest is in the materials rather

than in the methods and equipment used in constructing highways. As pressure for new roads in previously undeveloped areas, and for substantial improvement of existing roads, continues to be applied, and the availability of suitable road-building materials is reduced, greater interest will have to be given to improving the quality of borderline or submarginal material to make it acceptable for roadway construction. However, efforts must also be made to continually keep abreast of new technology in construction equipment and to devise better methods of supervising and testing the performance of highway construction contractors.

MAINTENANCE:

Research has not been applied extensively to the maintenance function. However, there is evidence that the neglect cannot be tolerated much longer. As the total miles of highways increase, design standards are raised, and traffic use continues upward, maintenance activity is likewise multiplied and could logically reach the point where it would become the most important highway function. Thus, it is necessary that new maintenance methodology and technology be devised to accent efficiency in the performance of the function. This necessitates research into the maintenance organization; the use of equipment, personnel, and material; and the level of maintenance as related to roadway function.

ADMINISTRATION:

At the National level, a great deal of interest has been devoted in recent years to improving highway administration, because it is realized that improvements in this function must often come before improvements can be expected in the other functions. The essential aim of "administration" is to effectuate the policies established by the administrators, but as the area of highway interest continues to broaden it will also become increasingly necessary for the administration function to furnish information to the administrators to be used to set policy; particularly to determine, on a continuing basis, just what position the Highway Department should maintain in the increasingly complex total field of transportation and in the overall development of the State as well. Research needs then to point to an examination of current administrative practices, and a study of the necessity of establishing newer and more flexible policies, especially in the area of the overall responsibilities of the Highway Department.

PLANNING:

Planning is just beginning to assume its full role, and research will be a valuable tool in helping this function expand and perform properly. At the present time, there is considerable interest in all phases of highway planning at both the National and State level. The public is becoming increasingly aware of the importance of transportation in their lives and has caused highway policies to be broadened to include study and evaluation of public benefit as part of preliminary planning for highways. Then, too, the increasing need for highway

improvements, coupled with a required exact budgeting of funds, has emphasized the need for planning. Research, if it is to help "planning" grow and is to provide it with tools to implement its duties, will have to delve into defining the scope of highway planning, as well as investigating the methods and procedures to be used in accomplishing "planning". Particular interest should be given to determining the place that highway planning has in the planning process which deals with the whole realm of socio-economic progress.

APPLICATION OF RESEARCH:

The foregoing highway research "needs" are not intended to serve as a list of research projects but as a base to determine how the four previously discussed types of research would be applied in the Research Section of the Highway Department and how its organization would be affected.

1 Basic Research: Basic highway research can be either physical or abstract, but its end result would be new ideas and conceptions rather than new methods or procedures. Since the functions of design, construction, and maintenance are principally "application" functions, the products of basic research would have to be examined by applied research methods before they could be of direct benefit. However, the function of administration, and planning to some extent, is more receptive to "raw" new ideas since they are largely policy-making and could utilize basic research methods in the quest for new knowledge concerning their functions. But since basic research is characterized by a lack of administrative control, a lack of foreordained end product, and a lack of definite time limits, it does not aptly fit into an organization such as the Highway Department. Thus, it is anticipated that basic highway research will not be a primary part of the Highway Department's research program but that the Department will participate in basic research usually through National highway organizations such as AASHO and the Bureau of Public Roads.

The Highway Department should not, however, "close the door" to basic research but should be guided by the words of a Department of Defense Committee report:

" having a field of application in mind, it is meaningful and sensible for a research administrator, without in any way influencing the creative atmosphere within which the researcher himself operates, to judge that certain areas of basic research have, with high probability, relevance to his practical interests."

2 Applied Research: Since applied research has been defined as a technical undertaking aimed at solving practical problems, and the Highway Department is essentially a technical organization which performs practical functions and is, therefore, continually faced with a myriad of practical problems, it is evident that applied research will be of primary importance to the Department.

The research needs of the design, construction, and maintenance functions can be directly satisfied by applied research methods since these needs are almost exclusively practical in nature. The needs of the administration and planning function are also adaptable to applied research but in a more restricted way, as will be brought out later.

The principles of applied research, which are basically a narrowly defined problem and a pre-determined form of end results, usually recommendations for action, can be utilized in two ways: (1) by examination of or experimentation on underlying concepts revealed by basic research; (2) by studying and testing problems ensuing from practical experience. Either of these are admirably suited to both the needs and capabilities of the Highway Department. Hence, it can be predicted that future research by the Arkansas State Highway Department will be largely conducted in accordance with the aims, purposes, and methods applicable to applied research.

3 Development Research: Development research is a type of applied research where the end product is either an abstract or physical model to be used in solving a series of common problems. Abstract models would include mathematical equations or formulas that may be applied to the solving of a practical problem, and physical models would include prototypes or patterns upon which a series of physical objects or tools would be based. Either of these would be directly applicable to the elemental functions of the Highway Department. Construction and maintenance would probably benefit more from physical models and administration, planning and design from abstract models.

4 Operations Research: This type of applied research usually presents recommendations to guide in the formulation of executive decisions or policies. Since the function of highway administration is primarily concerned with establishing and coordinating executive policy, it is evident that operations research will be especially suitable to the investigation of administrative problems.

From the foregoing, it is apparent that the research needs of the Highway Department will be primarily practical in nature, but not exclusively; and will encompass all of the basic functions now relegated to the Department. It is also obvious that applied research will be the main research method used to investigate and study the needs and to produce definitive information to help properly satisfy our highway responsibilities.

IV. METHODS OF RESEARCH

Inherent in all properly conducted research efforts, regardless of purpose or end product, is the rigid adherence to specific research procedures commonly known as "scientific method." To understand this method, it will be necessary to briefly consider a definition of science.

All knowledge may be assigned to one of three categories; i.e., science, speculation, or superstition. The rule of assignment is not the degree of truth attached to the knowledge but the extent that the truth can be proven. Thus, superstition may be termed knowledge based

on faith, and accepted without proof; speculation is knowledge resulting from reasoning or logic that has not been proven empirically; and science is knowledge that has been proven by sensual experience. The scientific method has been developed as a means of controlling the process of sensual experience to insure that an acceptable level of proof is obtained, so that the body of scientific knowledge can be truly expanded. To serve its purpose, then the scientific method must include these elements: (1) a sharp definition of the aspect of knowledge to be studied or examined; (2) the collection of all information that has a bearing on the idea under study; (3) analysis of the data to illustrate the exact relationship existing between the data and the idea; and (4) the formulation of substantiated conclusions and definitive information based on, and only on, the analysis of the data collected.

By definition, it has been determined that highway research in the Arkansas State Highway Department is to be scientific in nature; hence, it is mandatory that the principles of scientific method be followed in conducting research. These same methods can also be applied to the reporting of the research project, for the method of presenting the material pertinent to the project should follow the methods used to obtain the material in the first place. This becomes of particular importance when it is realized that the overall aim of any research endeavor is to channel information to an audience in a form that is readily acceptable to them and thus the report should present the information in the same order and style as it was originally produced to aid in its acceptance as proven facts.

It is realized that more detailed study of research and research reporting methods must be made before exact criteria can be formed to adequately control and regulate research activities done by, or for, the State Highway Department; however, it is not within the scope of this report to go that far. This need will be looked to at a later date.

V. THE RESEARCH ORGANIZATION

A proposed definition of the word "research" has been presented, the past and current highway research activities of the Highway Department have been discussed, general research needs and capabilities have been studied, and broad research methods and procedures have been illustrated; so it only remains to analyze other highway agencies' research organizations in an effort to devise and recommend an organization to control and coordinate research activities in the Arkansas State Highway Department.

In 1953, the Highway Research Board ^{11/} investigated existing research organizations in the then 48 states, plus Alaska, Hawaii, and Puerto Rico; and found that all states had some type of research organization pattern. The following table shows a breakdown, and

Figure No. 1 graphically illustrates the types of patterns.

Non-centralized research	30 states
Centrally coordinated	5 states
Formal	10 states
Joint	<u>6</u> states
	51

The same report defined the research patterns to be:

Non-centralized Research: "Non-centralized research is that research undertaken by various units of the highway department without special organizational framework. This is the traditional type in both state highway departments and universities. The individual operating function (division, bureau, or district) initiates the project of research or investigation, securing approval and authorization of funds as necessary. Active direction of the project often resides with the initiator."

Centrally Coordinated Research: "In centrally coordinated research, the various units of the highway department conduct research which is programmed and assigned by the executive branch of the highway department and coordinated by a research director. Central coordination provides a means of assessing the relative need of each proposed project and for including the most-needed projects to obtain a balanced, continuing program. It also allows scheduling of the individual projects to take advantage of the researchers and facilities."

Formal Research: ". research by these formal, self-contained, centrally operated units officially designated or recognized as research units (or divisions) in the state highway departments. This type of unit is sometimes responsible for the whole program but may assign parts of it to outside agencies. It has its own director and conducts its own operations, performing research and investigations for other operating divisions as occasion may require. This type of unit is distinguished from the joint research projects by pattern of top management, although each operates formally, with its own staff and facilities."

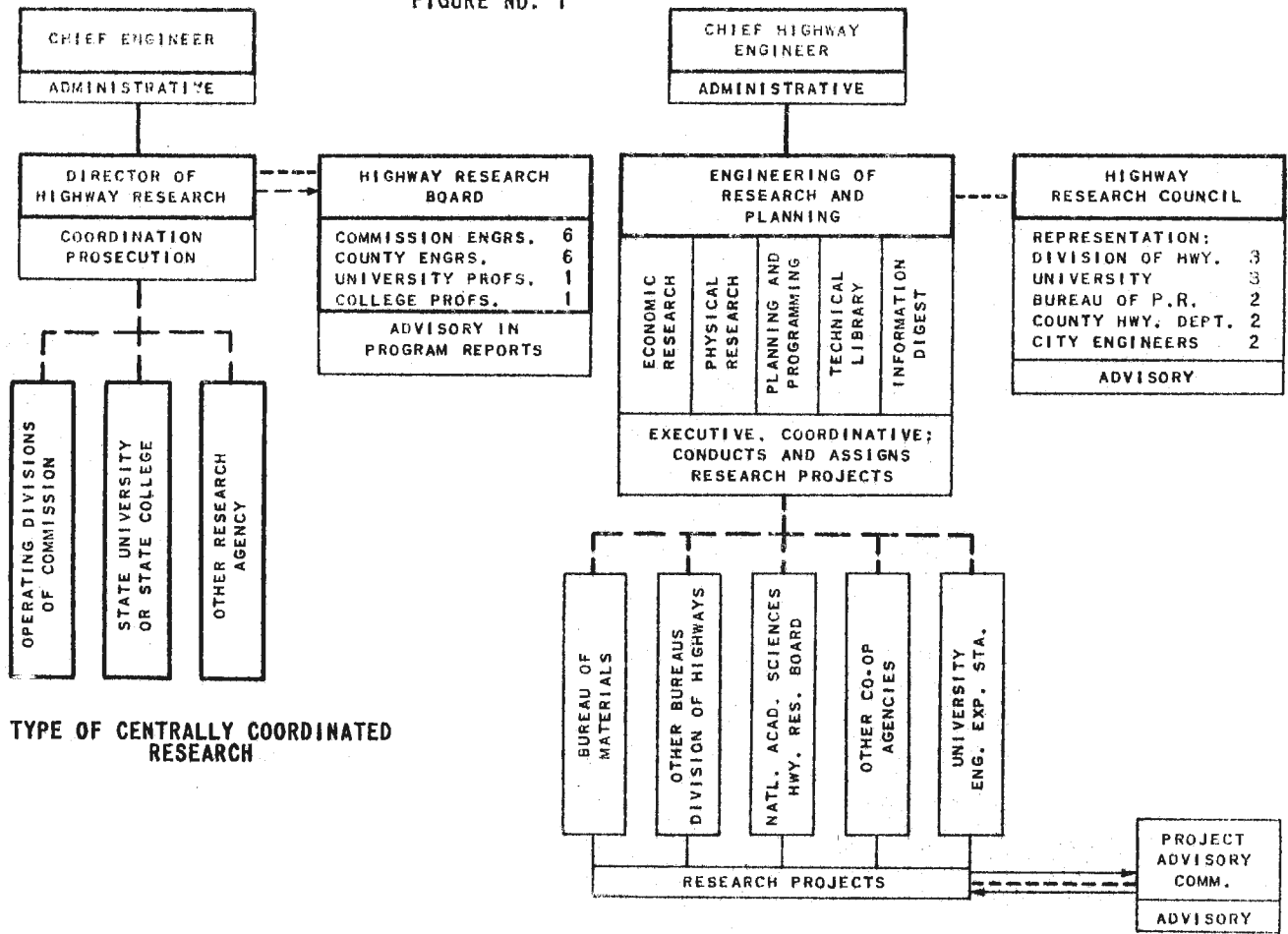
Joint Research (With Engineering Schools): "Joint research is that research conducted by organizations established and operated by joint effort and for the mutual benefit of the state highway department and the state university of college. Joint research does not preclude the operation of other highway research, either inside or outside of the state highway department, but the joint research program may constitute a major highway research endeavor within a given scale."

Each of the above types of research organizations have certain advantages and disadvantages that must be considered in their evaluation. The Highway Research Board Special Report 11 also included a discussion of these advantages and disadvantages, as brought out by the people actually working in or with each of the types. This discussion is presented below:

NON-CENTRALIZED RESEARCH

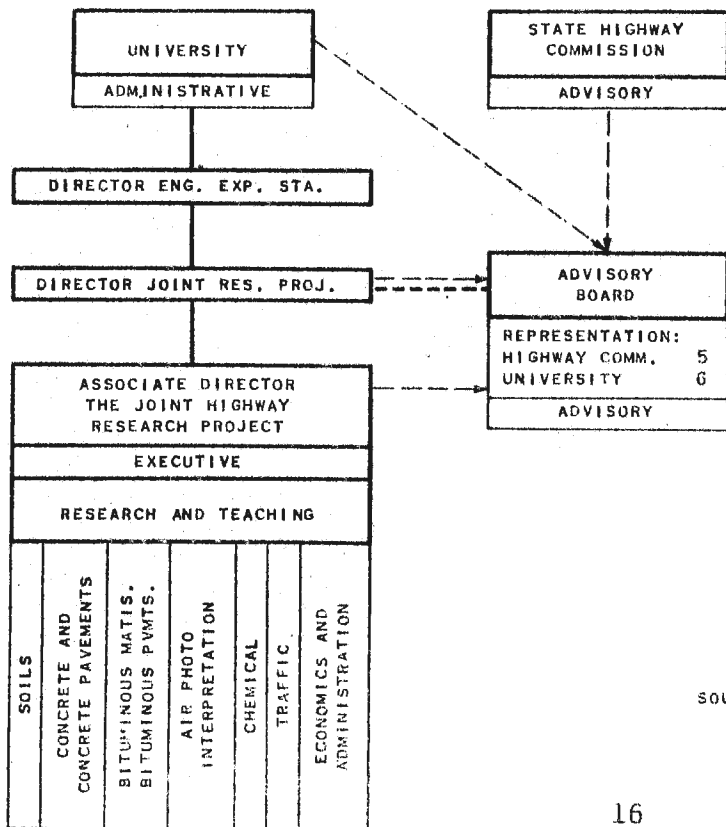
Advantages: (1) Flexibility; (2) rapid initiation and accomplishment; (3) adaptable to spontaneous problems; (4) reaches out to anyone with an idea; and (5) can use research projects to take up slack time.

FIGURE NO. 1



TYPE OF JOINT RESEARCH

TYPE OF FORMAL RESEARCH



LEGEND

- ADMINISTRATIVE, EXECUTIVE, SUPERVISORY
- - - COORDINATION, COOPERATIVE
- ADVISORY, COUNSEL
- ⇄ LIAISON, COMMUNICATION
- ⇨ REPRESENTATION

SOURCE: "HIGHWAY RESEARCH ORGANIZATION", SPECIAL REPORT 15, HIGHWAY RESEARCH BOARD, WASHINGTON, D.C., 1953 PP 4, 9, 12.

Disadvantages: (1) No comprehensive Research Needs program; (2) may lack thorough planning, including search of records and library for previous similar studies; (3) may lack continuity -- of sporadic character; (4) possibility of incomplete recording and reporting of projects undertaken; and (5) probable lack of dissemination of findings.

CENTRALLY COORDINATED RESEARCH

Advantages:

- (1) It retains advantages of departmental operations in sustaining an interest in research throughout the organization;
- (2) It takes advantage of opportunities for simple researches in any unit of highway department organization;
- (3) No elaborate research organization is required since the principal work of the research engineer is that of coordination, planning, and providing a clearing house and does not necessarily entail research operations;
- (4) The chief administrator and the heads of all operating divisions are close to all research activities and, therefore, are kept aware of requirements for changes in specifications and standards;
- (5) The advantages of noncentralized type of research are enhanced by coordination;
- (6) A mechanism is provided for formulating a program of all needed research, including physical or planning (abstract) research and for assigning projects to appropriate research units, either outside or inside of the State Highway Departments;
- (7) Research may be scheduled to use slack time of engineers (or other personnel) engaged in operations;
- (8) A central clearing house is provided for records and reports of research done by and for the highway department and for dissemination of research reports and publications of the highway department or other research agencies to the several operating divisions;
- (9) An organization is provided to encourage and stimulate research.

Disadvantages:

- (1) Responsibility for the research program and supervisory authority over operations are not always equal;
- (2) Research conducted in spare time by the operating divisions may result in discontinuity of effort.

FORMAL RESEARCH

Advantages: (1) Direct supervision of research personnel by the research engineer; (2) central coordination and statewide programming of highway research; (3) functionally designed laboratories provided with specialized equipment, effective use of library, professionally trained scientists employed on full-time basis which promotes efficiency in planning,

executing, and reporting research; (4) places emphasis on the research program and thus sustains the interest of the administrative branch of the highway department; and (5) provides for a continuing and long-range study with proper records and reports.

Disadvantages: (1) Usually (though not necessarily) a division (separation) of responsibility for physical and planning research; (2) poor communications between research division and operating divisions, no special liaison between researcher and operating engineer; and (3) a general lack of a formally constituted advisory council to assist in suggesting projects and to assist in getting the findings put to use.

JOINT RESEARCH

Advantages: (1) Provides the benefits of the complementary functions of research and teaching; (2) enlists interest of student assistants in highway employment; (3) provides training in the scientific method and advanced education; (4) provides necessary full-time researchers for a continuing program; (5) provides environment conducive to highway research, with specialized equipment, facilities, and the scientific resources of the university; (6) affords the combined technology of the scientist and the engineer, both in planning and in operating the project; (7) divorces research from operations and avoids conflicting interests; (8) provides the advantages of traditional university research with the added advantage of the feeling on the part of the staff of being a part of the highway enterprise; (9) facilitates reporting and recording; and (10) provides a stimulus for basic research.

Disadvantages: (1) The possibility that the research organization may lose its identity as a real part of the highway department, with the resultant lack of utilization of research findings by the highway department; (2) fulltime researchers may lose touch with highway department operations; and (3) limitation on program scope -- university may not be able to undertake a complete program of research for the highway department.

The preceding discussion illustrates how the various approaches to highway research by the several states may be arbitrarily classified into four types and presents advantages and disadvantages inherent in each of the types. It goes without saying that administrative policy and research implementation procedures can alter the advantages and disadvantages and materially affect the value to the type in a specific case. In evaluating these methods, it must also be remembered that the highway department's aims and purposes for conducting research have a direct bearing on the usefulness of the type of organization and that, normally, the highway administrators established the organization after determining the broad aims of research as a part of their highway department.

Since this present "research of research" has had an opportunity to examine the efforts of other older and well-established highway research organizations and is being conducted to serve as a guide in the creation of a research organization within the Arkansas State Highway Department, it is considered proper and advisable to reverse the above-mentioned process of development of a research organization and to propose a type of organization before determining the aims and purposes of the organization. In support of this idea, it is submitted that organizations are inherently more rigid in nature and more resistant to change than are administrative aims and policies. Thus, if sufficient knowledge is available to devise an organization that will adequately serve a wide range of purposes and not artificially preclude or restrict the formation of desirable policy changes, it is advisable to do so.

From the aspects of highway research brought out in this report, it can be stated that the purposes of the research organization would be to:

1. Promote and encourage the acceptance of highway research as a necessary function of the Highway Department.
2. Translate the State Highway Commission's policy on highway research into specific highway research projects.
3. Control and coordinate the execution of the projects, including a reviewal of progress and final results.
4. Recommend action to be taken on the findings of specific research projects.
5. Disseminate to appropriate Highway Department personnel the results of all highway research that would be of interest to these personnel.
6. Advise the State Highway Commission in regard to highway research administrative policy.

The study of the types of organizations devised by other highway departments indicates that certain elements will be necessary in any organization developed to satisfy the above purposes. These elements are:

1. An advisory group made up of people that will conduct research, apply the research results, and be in a position to determine research needs and capabilities.
2. This group should have direct access to top level highway management as well as to the lower echelons of the administration.
3. A permanent nucleus of research personnel should be established to give continuity to the research program under the advisory group's control.

4. The primary function of the research organization should be restricted to highway research.
5. The organization should be flexible, in that it should be able to meet the research needs determined by future highway administrative policy.

VI. RECOMMENDATIONS

Analysis and study of the foregoing data within the scope of this study has led to the following recommendations concerning research in the Arkansas Highway Department. It is realized that this research endeavor may be exceeding its bounds by recommending administrative policy in regard to research, but it does so only to be practical and with the clear understanding that the proposal of administrative policy is usually not the responsibility of the researcher. It is recommended:

1. That the Highway Department accept the definition of highway research as presented herein as a guide to the continued development of a comprehensive and organized highway research program;
2. That the Highway Department create a highway research advisory committee to guide the continuing program and that the committee organize and function in accordance with the general research criteria presented in this report;
3. That the Research Section of the Planning and Research Division be given the responsibility of administering, conducting, and reporting on research projects under the guidance and supervision of the proposed highway research advisory committee;
4. And that the advisory committee and the Research Section be charged with the preparation of detailed criteria to govern the composition and duties of the committee and the methods of administering, conducting, and reporting on research projects under their control.

REFERENCES

- (1) Webster's New International Dictionary, Second Edition, Unabridged.
- (2) "Your State Highway Department," Arkansas State Highway Department, 1961.
- (3) "Joint Highway Research Program," Arkansas State Highway Department and the University of Arkansas, 1956.
- (4) Continuing Cooperative AASHO Highway Research Program, 1961.
- (5) "Symposium on Basic Research," American Association for the Advancement of Science, Washington DC, 1959, p. 20.
- (6) "Applied Research in the United States," National Academy of Sciences, National Research Council, Washington DC, 1952.
- (7) S. C. Ogburn, Jr., Op. Cit.
- (8) "The First Annual Report of the National Science Foundation," U.S. Government Printing Office, Washington DC, 1950-51.
- (9) "Methods of Operations Research," Morse & Kimball, The Technology Press of the Massachusetts Institute of Technology and John Wiley and Sons, Inc., New York, p. 1.
- (10) "Highway Research in the United States," Special Report 55, Highway Research Board, Washington DC, 1959, p. 18.
- (11) "Highway Research Organizations," Special Report 15, Highway Research Board, 1953, Washington DC, p. 26.



APPENDIX A

Appendix A

Actions Taken on the Findings of the Report

The foregoing report was submitted, in a preliminary form, to the Director of Highways to guide the establishment of formal policy by the Highway Department in regard to highway research.

The Director of Highways, acting within the authority delegated to him by the State Highway Commission, subsequently executed an administrative order establishing the Highway Research Committee; stipulated that the first duty of the Committee would be to prepare a report outlining the proposed scope of the Committee's operation; and stated that research funds must be budgeted and approved in accordance with procedure governing the expenditure of Highway Planning Survey funds.

Shortly thereafter, the Director of Highways formally appointed members to the Committee and called an organizational meeting. A diverse membership was selected so that the Committee would include not only Highway Department personnel, who by their experience and administrative position represented the full scope of Highway Department operations, but also University of Arkansas and Bureau of Public Roads personnel who could materially assist the Committee in the performance of its functions.

Alternate members were concurrently appointed to insure that effective representation of the membership would be more likely achieved. Ex-officio membership was also established, in principle, so that the Highway Research Committee could take advantage of assistance from personnel of agencies not originally represented on the Committee.

The organizational meeting of the Highway Research Committee was held on May 24, 1962. At this meeting it was determined that: (1) the Committee should be limited to advisory, in contrast to executive, functions and should always work within whatever administrative chain of commands it encounters; and that (2) the duties and authority of the Committee would have to be clearly spelled out in advance of active participation in Committee affairs by agencies outside of the Highway Department.

In consideration of these points, the Chairman of the Committee directed that a Committee Constitution be prepared and submitted to the members for adoption. This document was to reflect the policy of the Highway Department as contained in the foregoing report, and the Administrative Order executed by the Director of Highways as well as the desires of original Committee members as presented at the organizational meeting.

The Committee Constitution, Bylaws, Standing Rules for Conduct of Business, and Guidelines for Research Activities were adopted by the Committee membership in September 1962.

On October 19, 1962, the Highway Research Committee held its first regular meeting under the Committee Constitution and Bylaws adopted the month before. At this meeting the Committee accepted the sponsorship of 12 research proposals and directed the chairman to appoint project subcommittees to guide the conduct of research outlined by the accepted proposals. Subsequently the Director of Highways executed Administrative Circular No. 62-53 which encouraged cooperation between the Department Staff and the project subcommittees.

Appendix A is concluded by the four following exhibits which aptly summarize the initial actions taken by the Highway Department to establish an organization to promote highway research.

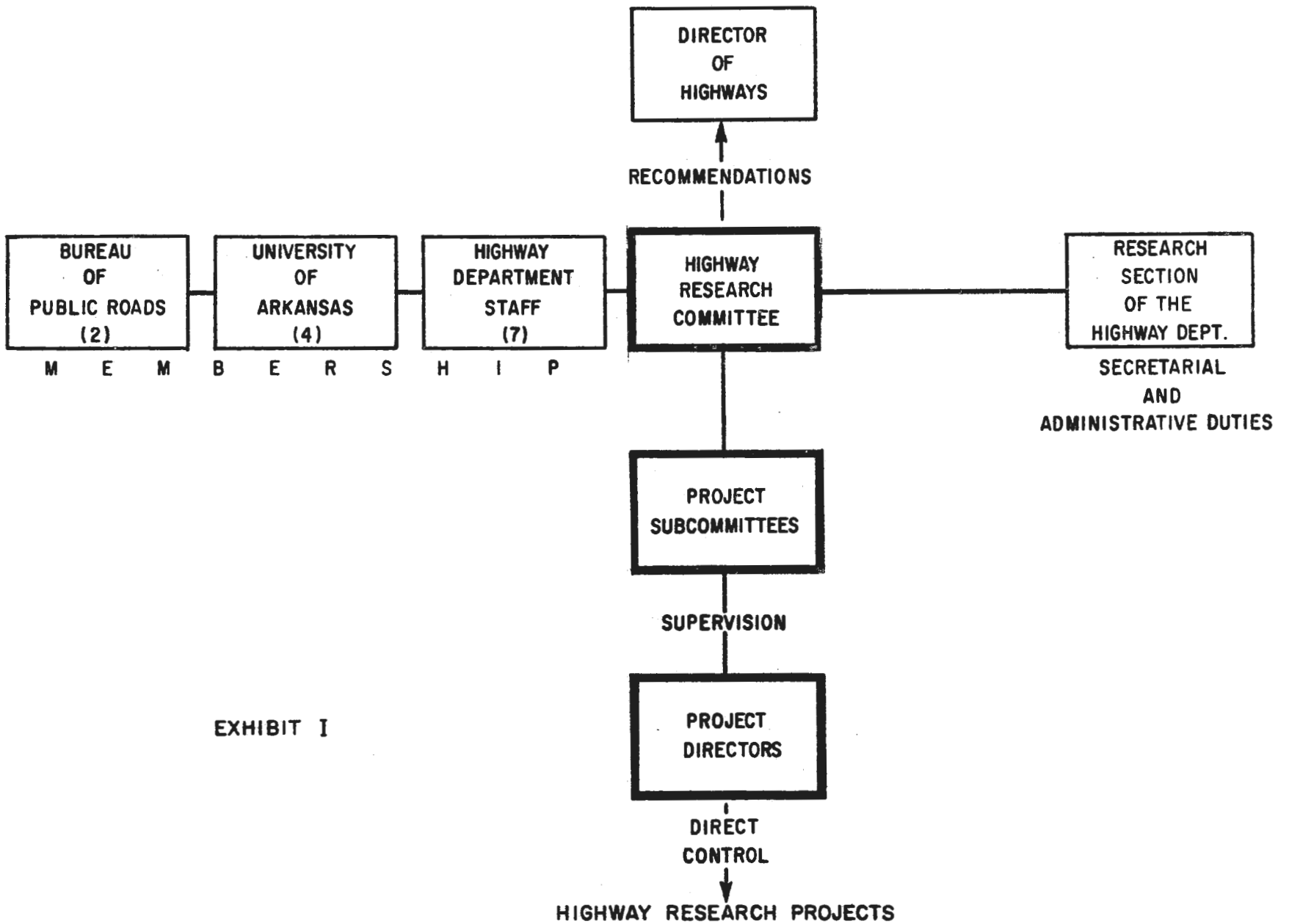


EXHIBIT I

EXHIBIT II
CONSTITUTION
ARTICLE I

NAME. The name of this committee shall be THE ARKANSAS HIGHWAY RESEARCH COMMITTEE, hereinafter referred to as the Committee; a cooperative organization representing the Highway Department, Bureau of Public Roads, and other State institutions or agencies all having common interest in promotion of research in the field of highway transportation.

ARTICLE II

OBJECTIVES. The Committee has been created under the authority of Highway Department Administrative Order Number 62-5 of March 7, 1962, with the following objectives:

- A. To promote and encourage highway research as a necessary function of the Highway Department, as an essential element in the State's program of higher education, and as a vital measure in the improvement of public transportation.
- B. To translate State Highway Commission policy into specific highway research projects.
- C. To coordinate highway research activities, develop comprehensive research programs, screen research project proposals, and review the results of the research projects.
- D. To recommend action in regard to application of the findings of highway research activities.
- E. To disseminate the pertinent information from highway research.
- F. To develop personnel and facilities adequate for a full and continuing program of highway research.
- G. To accomplish these aims within the framework of existing laws, rules, regulations, and policies of the cooperating agencies comprising the Committee.

ARTICLE III

MEMBERSHIP. The Committee shall be composed of representatives of the Highway Department, the University of Arkansas, Bureau of Public Roads, and other cooperating State agencies. Membership from the Highway Department will include those employees designated by the Director; and from cooperating agencies shall be limited to the number specified in an invitation by the Director and named in writing by the head of the cooperating organization. An alternate shall be named for each member, to

serve in his stead at any meeting or on any Committee activity. Membership shall not exceed the number specified by Administrative Order of the Director of Highways.

The Committee shall be authorized to expand the organization within the scope of Article II and on a non-voting membership basis, by appointment of subcommittee (Associate) members from the cooperating agencies by the Chairman, with the consent of the affected agency and the approval of the Director of Highways. Associate membership shall be limited to specific research activities as specified by such appointment.

Ex-officio membership on a non-voting basis shall be limited to those individuals designated by the Director of Highways to serve on the Committee in an official capacity.

ARTICLE IV

OFFICERS & ELECTIONS. The Officers of the Committee shall be a Chairman and a Vice-Chairman, elected from the membership for two-year terms; and a Secretary, who shall be an ex-officio member.

- A. Elections shall be by secret ballot and shall require only a simple majority of those voting to elect.
- B. Elections shall be held at the first regular (February) meeting in even-numbered years, and the new officers shall take office immediately upon election.

ARTICLE V

MEETINGS & QUORUM. The Committee shall be limited to a necessary minimum of regular meetings, but the number of called special meetings shall be contingent upon the proper pursuit of Committee objectives.

- A. The Committee shall meet regularly on or about the last Wednesday in the months of February, June, and October of each year.
- B. The time and place of any meeting will be determined by the Chairman, who shall instruct the Secretary to notify members at least 30 days prior to the date selected.
- C. The Chairman may call special meetings for the purpose of acting upon specific Committee business which cannot be appropriately conducted at a regular meeting.
- D. A majority of the members or their alternates shall constitute a quorum for all meetings.

ARTICLE VI

AMENDMENT. The Committee Constitution may be amended according to the following procedure:

- A. Written copies of proposed amendments shall be submitted to the Secretary, who shall submit one copy to each member at least 30 days prior to the meeting at which the proposed amendment is presented for adoption.
- B. The adoption of the proposed amendment shall be determined by a three-fourths majority vote in the affirmative by the members and approval by the Director of Highways.

BYLAWS

ARTICLE I

MEMBERSHIP. As presently authorized, the Committee shall include not less than nine nor more than fourteen members representing the construction, maintenance, design, administration, and planning functions of the Arkansas Highway Department; the research activities of the University of Arkansas; and the Bureau of Public Roads.

- A. Members shall be appointed by the Director of Highways as set forth in Art. III, paragraph one, of the Constitution, and a memorandum of such appointment will be accepted by the secretary as accreditation to the Committee. Members shall have full authority to participate in Committee business, serve as officers, serve on subcommittees, and vote on all questions which may come before the Committee. Membership may be terminated only by resignation or by the withdrawal of accreditation.
- B. Associates may be appointed to the Committee by resolution duly adopted at any regular meeting of the Committee subject to the approval of the agency they represent. The resolution of membership shall specify the project or activity for which the appointment is made and completion of the specific project or activity shall terminate the Associate membership. A resolution of membership may be initiated by any member under Special Order of Business. Associates shall never number more than fifty percent (50%) of the membership and shall be selected by reason of the special knowledge, training, experience, or skill they are enabled to bring, in an advisory capacity, to projects, problems, or activities in the purview of the Committee's interest and objectives. Associates may participate in the discussion of any business before the Committee and may serve on project subcommittees, but shall never initiate or introduce business nor vote upon any question. The Director of Highways may also designate any highway employee as an associate by issuance of an Administrative Order to the Chairman of the Committee.
- C. Alternate members are designated in the same manner as members, each as an alternate to a specific member. In the disability of his member, the Alternate shall function as his deputy but only upon receiving written instructions from his principal (with a copy to the Committee Secretary) in advance of the meeting as to the necessity for and specific duration of such action. Alternates may attend meetings but shall not initiate, introduce, nor vote on business before the Committee except under a specific written authority of his principal. As regards the tenure of office, duties, and privileges of his position, all rules pertaining to members shall apply except as set out in this subsection of these By-Laws.

- D. Ex-officio members named from the Highway Department by Administrative Order of the Director to serve in an official capacity to the Committee shall serve at the pleasure of the Director and shall have all privileges of membership except voting. The Secretary shall be an ex-officio member.

ARTICLE II

DUTIES OF THE OFFICERS.

- A. It shall be the duty of the Committee Chairman to preside at all regular or special Committee meetings.
- B. The Chairman may appoint a Chairman pro tem to preside over the conduct of a specific item of business.
- C. It shall be the duty of the Vice-Chairman to preside in the absence of the Chairman unless a Chairman pro tem has been named.
- D. It shall be the duty of the Secretary to perform administrative duties as the Chairman may direct before, during, and after Committee meetings.
- E. The duties of Associates shall be confined to those necessary for the proper prosecution of the functions assigned to them.

ARTICLE III

MEETINGS - ORDER OF BUSINESS. Regular meetings shall be held as provided in Article V of the Constitution. The order of business shall be as follows:

Minutes
Announcements and reports by the Secretary
Reports by Subcommittees
Special order of business
Regular order of business

The order of business may be altered at any regular meeting by a two-thirds vote upon a motion immediately after the reading and approval of the Minutes.

Special meetings shall be held as provided in Article V of the Constitution. No business other than that stipulated in the advance notice shall be considered.

ARTICLE IV

SUBCOMMITTEES. The Chairman shall have the authority to appoint subcommittees within the following limits:

- A. The objective of the subcommittee shall conform to Art. II of the Constitution.
- B. Project subcommittees shall function to coordinate the committee's interest in research projects. A project secretary may be appointed to perform administrative duties for the subcommittee if the subcommittee so desires.
- C. Administrative subcommittees shall function to carry out tasks of facilitation and administration assigned by the Chairman.
- D. The majority of a project subcommittee shall always be selected from the Committee members and the chairman of the subcommittee shall always be a Committee member.
- E. The subcommittee shall meet as often as the Chairman of the subcommittee may direct but at least one meeting shall be held between regular Committee meetings.
- F. Actions of the subcommittees shall be reported to the Committee at each regular meeting and are subject to approval of the Committee.
- G. The Committee officers shall be members, ex-officio, of all subcommittees.

ARTICLE V

EXECUTIVE BOARD. An Executive Board shall be composed of the Chairman of the Committee, as Chairman, the Committee Vice-Chairman, as Vice-chairman, the Committee Secretary, as secretary, and two members elected by the Committee.

The Executive Board shall meet immediately prior to a regular committee meeting or when called by the Chairman or two or more members.

The Executive Board shall have authority to act on matters which in the judgment of the Board must be acted upon before the next regular meeting of the Committee but may not act to delete items entered on the Agenda as Special Order of Business.

The Executive Board shall make a full and accurate report of its discussion and action at the subsequent regular meeting.

ARTICLE VI

PARLIAMENTARY AUTHORITY. All business meetings of the Committee and its subcommittees shall be governed by the rules contained in Roberts Rules of Order, Revised, in all cases in which these rules are applicable and consistent with the Constitution and By-Laws of the Committee.

- A. Standing Rules shall be adopted to guide the Committee in the conduct of meetings and Committee business. The standing rules may be suspended during a convened session by a majority vote of members present and voting. The standing rules may be amended by a two-thirds vote of members present and voting.
- B. Guidelines for Research Activities shall be adopted to guide Project Directors and Subcommittees.

ARTICLE VII

AMENDMENT. The Committee By-Laws may be amended as provided in Article VI of the Constitution except that only a two-thirds majority of the members must vote affirmative.

STANDING RULES FOR CONDUCT OF BUSINESS

Note: Provisions have been made in the By-Laws for adoption of whatever Standing Rules the Committee may need, but none are proposed at this time. If there are rules which you believe should be proposed, please submit them to the Secretary.

GUIDELINES FOR RESEARCH ACTIVITIES

I. GENERAL

The guidelines shall pertain to the conduct of all research activities sponsored by the Committee, or subcommittees thereof. The guidelines may be amended, rescinded, or suspended by a simple majority vote during a regularly convened meeting of the Committee.

Project subcommittees shall have authority to temporarily amend or suspend these guides if in the opinion of a majority of the subcommittee such action is vital to the proper supervision of the project, if the amendment or suspension is not in conflict with the Constitution and By-laws, and if the amendment or suspension is reported to the Committee Chairman as soon as possible after enactment. The actions or the subcommittee shall be reported to the Committee at the next regular meeting and are subject to approval by the Committee.

II. FORMATION OF RESEARCH PROJECTS

- A. Preliminary research proposals shall be submitted to the Committee for review on Form No. P&R-503. The completed form may be submitted to the Chairman, the Secretary, or a member at any time, but the preliminary proposal shall be considered only during a regular meeting or a special meeting called for the purpose of considering proposals.
- B. The Committee shall either accept, reject, or defer for further study all preliminary proposals duly submitted.
- C. On accepted items, a project subcommittee shall be established to guide the preparation of a formal project proposal that shall serve as the basis of agreement between the Committee and all agencies involved in the project and as a specific guide for the personnel to be actually engaged in the research.

The project proposed shall be a specific and comprehensive presentation of the proposed research project and shall include, but not necessarily be limited to, the following items:

1. Title - A clear, concise statement of subject.
2. Purpose - A statement of the problem or a definition of the area of highway science to be researched, including background data relative to the importance of the study, aims, purposes, and the possible applications of the findings.
3. Scope - A statement of the range of the project along with limits of the subject to be studied and assumptions or hypotheses to be proven.

4. Procedures and Methods (General) A description of the methods to be used in collecting and analyzing office, field, and laboratory data relative to the project.

Sources and availability of data and special equipment required. Special provisions that may be required to completely describe the proposed research project.

5. Project Organization and Administration - A statement concerning the personnel and/or agency to perform the research and the authority, either statutory or executive, upon which the statement is based. A statement concerning the person, office, or agency to have responsibility for executing the project. Availability of qualified personnel.
6. Time - An estimate of time to complete the project. If the project will proceed in phases, show an estimate for each phase. Also indicate the approximate desirable date for beginning the project.
7. Cost - An estimate of cost showing a breakdown of the elements of cost including: salaries, equipment costs, material costs and overhead. Each element should also be broken down by appropriate sub-elements. Statements concerning sources of financial support and publication and dissemination of project findings, conclusions, and recommendations.

The completed proposal should include signatures indicating formal approval by appropriate personnel in the agency to conduct the research.

- D. The completed project proposal should be submitted through the proper channels of the agency proposing the research to the Secretary of the Highway Research Committee for processing.
 1. Projects sponsored by the Highway Department and the University of Arkansas will be considered as extensions of the Joint Highway Research Basic Agreement and shall be processed in accordance with procedures contained therein.
 2. Projects sponsored only by the Highway Department will be processed through the office of the Chief Engineer.
 3. Upon approval by State agencies involved, projects in categories 1 and 2 involving participation by the Bureau of Public Roads will be processed through the Planning and Research Division of the Highway Department for submission to the Bureau of Public Roads.
 4. If the completed project proposal differs substantially from the preliminary proposal upon which it was based, it shall be processed through the Executive Board of the Committee for recommendations as to further action.

- E. Upon receipt of notification from the Committee Secretary that a project proposal has been approved and work may begin, the project subcommittee shall request that the project director prepare a detailed Work Outline showing the schedule, procedures, and methods for executing the project.
- F. At the Work Outline stage, minor alterations or amendments may be made in an approved project proposal by the project subcommittee if in the opinion of a majority of the subcommittee such action is vital to the proper execution of the project and if the alteration or amendment is reported to the Committee Chairman as soon as possible after enactment. The actions of the subcommittee shall be reported to the Committee at the next regular meeting and to the agencies that originally approved the project proposal, and are subject to their approval.

III. CONDUCT OF RESEARCH PROJECTS

- A. It is the intent of the Committee that all research projects under their sponsorship shall be conducted in accordance with the basic principles of scientific method with the researching agency making every effort to produce substantiated conclusions that will truly expand the knowledge of highway science.
- B. The researching agency shall at all times be responsible to the Committee for the proper conduct of research projects insofar as the Committee sponsorship is concerned.

IV. ADMINISTRATION OF RESEARCH PROJECTS

- A. After formation, approval, and activation of a research project the function of the Committee and project subcommittee shall be to advise and guide the conduct of the project through the project director and in accordance with the approved Work Plan and duly executed amendments thereto.
- B. The Committee or project subcommittee may recommend the appointment of a project director and project staff, but formal appointment of the project director and staff shall be by the agency or agencies directly involved in the execution of the project in accordance with their established administrative procedures.
- C. An account of research project activity shall be submitted monthly, or at such intervals as may be provided in the project agreement, to the Committee directly or through the project subcommittee if one has been appointed. The project secretary shall transmit an appropriate number of copies of the activity report to all agencies directly involved in the project.
- D. The Committee and/or project subcommittee shall have the right

to inspect at any time the office, field, and laboratory work connected with all research projects under the Committee's sponsorship.

V. DISSEMINATION OF THE RESULTS OF A RESEARCH PROJECT

- A. The Committee or project subcommittee if one has been appointed shall review and act on formal research project reports submitted by the project director.
- B. Reports that are accepted shall be transmitted by the Committee to interested agencies along with Committee recommendations relative to the use of the data and findings contained in the report.
- C. Formal release of data, conclusions, or recommendations issuing from a research project shall not be made without prior approval of the Committee, unless otherwise provided in a Basic Agreement or Project Agreement for the conduct of this research.

EXHIBIT III

ARKANSAS STATE HIGHWAY DEPARTMENT

Little Rock, Arkansas
March 7, 1962

ADMINISTRATIVE ORDER 62-5
TO: ALL DIVISION HEADS - DISTRICT ENGINEERS
SUBJECT: HIGHWAY RESEARCH PROGRAM

The Critical need for an accelerated program of comprehensive research in the Department to provide information essential for the proper planning, design, construction, maintenance, and financing of highways and highway systems has been recognized by the establishment of and allotment of funds for a research section in the Division of Planning and Research. In addition to the present research activities of our Department, the Commission in December 1961 approved participation in a continuing highway research program sponsored by the American Association of State Highway Officials. Also the Bureau of Public Roads on February 2, 1962, placed increased emphasis on highway research on a nationwide basis by issuance of a policy memorandum (PPM50-1.1) stating that henceforth the 1½% Highway Planning Survey Funds shall be utilized entirely for planning and research purposes.

Even though a Divisional unit has been organized to promote research work, the full discharge of our highway research responsibilities, the establishment of a well-balanced program and the proper utilization of the results thereof, requires that the scope be broadened and a controlled and coordinated research program be developed on a Department-wide basis with participation by representatives from all phases of highway work.

Therefore, in line with this premise, a Departmental Research Program is hereby authorized and established in accord with the following policies and guides:

1. A Highway Research Committee shall be established to direct the program in accordance with the attached "Composition and Duties of the Arkansas State Highway Department Research Committee."
2. The first duty of this Committee shall be to prepare a report that will include a definition of the proposed scope of the activities of the Highway Research Committee. The report shall be submitted promptly to the Director for approval.
3. The total expenditures for the purposes of highway research under the supervision of the Committee shall not exceed the funds budgeted and approved for this purpose during any one fiscal year. Research projects selected shall be eligible for participation in 1½% Highway Planning Survey Funds.

Appointment of the Departmental members of the Highway Research Committee will be announced in the near future and a date set the organizational meeting.

/S/ F. R. OLIVER
Director of Highways

COMPOSITION AND DUTIES OF THE HIGHWAY RESEARCH COMMITTEE

1. The Committee will be composed of three types of members.
 - a. Full members who shall have voting privileges.
 - b. Ex-officio members who shall have authority to participate in the Committee's business but shall not have voting privileges.
 - c. Administrative members who shall perform duties at the discretion of the Committee without voting privileges.
2. Full members shall include not less than seven nor more than twelve persons representing the five primary functions of the Highway Department, i. e., construction, maintenance, design, administration, and planning, and the College of Engineering and the Engineering, Business, and Economic Research activities of the University of Arkansas.
3. Ex-officio membership shall not exceed six persons who shall be representatives of the Bureau of Public Roads, or other official or quasi-official agencies directly concerned with the execution of the five primary functions of the State Highway Department.
4. Administrative membership shall be composed of a secretary plus additional personnel necessary to perform administrative duties as determined by the Committee.
5. All members of the Committee, regardless of type of membership, shall be assigned or accredited to membership by the Director of Highways in accordance with the above criteria.
6. The Committee shall have the general duty, and commensurate authority, to fully supervise, control, and/or regulate all highway research performed directly by, through, or for the Arkansas State Highway Department and to coordinate this research with highway research conducted by other agencies which is of interest to the Arkansas State Highway Department.
7. In order to properly discharge its general duty the Committee will perform the following specific functions:
 - a. Meet as often as it shall deem necessary to consider the business brought or caused to be brought before the Committee by the membership.
 - i. Meetings will be scheduled regularly not more than once per month nor less than once per three months.
 - ii. Special meetings may be called at the discretion of the Chairman of the Committee.
 - b. The place of meeting will normally be the Central Office of the State Highway Department; however, the Committee Chairman may determine the place of meeting for any and all special or regularly scheduled meetings.
 - c. The Committee shall meet at the first opportunity after the initial Committee members are assigned or accredited for the purpose of establishing rules and regulations necessary for the proper operation of the Committee and for the consideration of present or future business.
 - d. The Committee shall prepare, or cause to be prepared, as soon as possible after being organized and as often thereafter as the Director of Highways may direct, a report or reports presenting a definition of highway research applicable to the needs and desires of the Arkansas State Highway Department, criteria on the methods to be used to propose, conduct, and report research projects, and methods to be used to integrate research into the functions of the Highway Department.
 - e. The Committee shall review and disseminate to appropriate Highway Department Division Engineers, with or without endorsement, any and all information and data resulting from research, either controlled by the Committee or performed by others, that may be brought before it by the members.
 - f. The Committee shall prepare, or cause to be prepared, and shall review and act on proposals for all research projects to be conducted by, through, or for the State Highway Department.
 - g. The Committee shall prepare, or cause to be prepared, progress reports for all research projects under its supervision or control.
 - h. The Committee shall receive, review, and act on, as it deems appropriate, final reports and/or publications of research under its supervision or control.
 - i. The Committee shall have the responsibility to periodically review research project cost estimates submitted at the direction of the Committee and it shall have the authority to recommend action as it deems necessary. This responsibility and authority may be delegated to a full member, or members, of the Committee as the Committee may direct.
 - j. In all cases, the Committee shall submit to the Director of Highways, or his deputy, a true account of all business conducted by the Committee during regularly or specially scheduled meetings.

EXHIBIT IV

ARKANSAS STATE HIGHWAY DEPARTMENT
LITTLE ROCK, ARKANSAS

November 2, 1962

ADMINISTRATIVE CIRCULAR NO. 62-53

TO: DIVISION HEADS AND DISTRICT ENGINEERS

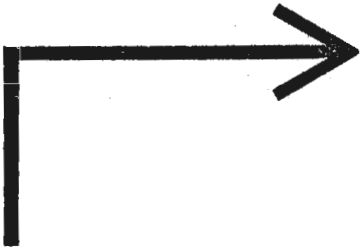
SUBJECT: Administration of Highway Research

The Highway Research Committee authorized by Administrative Order 62-5 of March 7, 1962, is now an active organization and has reviewed and recommended for programming a number of excellent research projects.

In time many of you and your staff members will be requested by the Committee Chairman, Mr. Henry Schneider, to assist in the development, administration, guidance, and review of a specific research project by serving as a member of a Project Subcommittee. Cooperation throughout the Department is essential if a comprehensive, worthwhile program of research is to be carried on, and you are urged to support the Research Committee to the extent your regular duties permit. A Project Subcommittee will not normally meet more than once per month for three to four hours, and you will consider this time as a part of your regular administrative expense.

Practically all research projects will be financed with Federal-Aid Highway Planning Survey Funds, and each will be supervised by a Project Director selected by the Project Subcommittee. Personnel from your organizations engaged in the actual research activities and the Project Director will charge their time and expenses to the Federal-Aid project number assigned to the research work.

/S/ F. R. OLIVER
Director of Highways



APPENDIX B



Appendix B

Resume of Research Facilities Available to the Highway Research Committee

It should be acknowledged that the future success of the highway research program sponsored by the Highway Research Committee will be largely dependent upon the research facilities, or tools, available to it rather than upon the organization itself. The following resume of research facilities is presented, because of their importance, to show in a general way the implements which the Committee may call on to further their objectives. These implements have been grouped into four categories: (1) personnel to perform and supervise the research work; (2) equipment to carry out the necessary tests and measurements; (3) time to devote to the research projects; and (4) money which may be allocated to finance the projects.

I. PERSONNEL: The single most important facility available to the Committee is qualified personnel to supervise and/or conduct highway research. Two groups of personnel may be recognized according to their type of qualification. First, would be that group who are well-grounded in theoretical knowledge but have obtained most of their experience in the application rather than the development of basic highway science. This group would mainly conduct applied research projects. Second, would be that group whose main experience has been in the development and teaching of basic theory and who would be primarily suited to conduct the more basic or comprehensive highway research.

A. Highway Department Personnel: The Department currently has 188 employees with college degrees who primarily constitute the group qualified to conduct applied research. The distribution of the degrees is shown as follows:

Bachelor Degrees		Graduate Degrees	
BA	15	MS	6
BS	28	MSBA	2
BSBA	8	MSCE	5
BSCE	103	MSE	1
BSIE	1	LLB	<u>15</u>
BSE	<u>4</u>		
Total	159	Total	29

Only four of the Highway Department's personnel are presently working on highway research projects, and it should be remembered that the remainder have primary duties that do not include research. However, in interviews held this past summer with top-level Highway Department staff members, it was brought out that many of the Department's qualified personnel would be available for research on a limited basis as long as the research project is essentially an extension of the person's normal duty and does not materially interfere with his appointed job.

In summary, the availability of Highway Department personnel to

conduct research will be limited, by nature of the personnel, to applied research and will be directly influenced by the scope and aims of the individual projects.

B. University of Arkansas Personnel: The policy of the University in regard to the availability of personnel to conduct highway research has been aptly presented by the Head of the Department of Civil Engineering in a paper describing the Civil Engineering Research goals.

"It is the goal of the Department of Civil Engineering to achieve a balance of instruction and research. Research is a desirable adjunct to undergraduate instruction and is almost a necessity in enrichment of graduate study. Also research must be nurtured in the various branches of study now recognized in the instructional area of civil engineering at the University and a balanced program within these areas is a desirable plan."

"Present plans to increase research personnel are restricted to the assignment of teaching personnel on a part-time research program during the academic year and full time research participation during the summer months, when teaching requirements diminish. Consequent with this proposed expansion in the research program, graduate course offerings must also be expanded. This means the immediate addition of full-time faculty of sufficient stature to immediately enter into such an advanced instruction-research program. The immediate request is for an addition to the faculty in the highways area and one in sanitary engineering, each of which would be scheduled on a half-time research, half-time teaching program. To entice the quality personnel needed to man these openings would require a 9-months salary in the \$8,500 - \$10,000 range. To assist high-salaried faculty, graduate assistants are more necessary than ever. Our recruitment program in this area will be increased but we are practically limited to our own graduates until our graduate program is more widely recognized and until we are able to offer a Ph.D. with major in civil engineering. Another alternative is to solicit assistance from the Highway Department through a cooperative graduate study-research plan. There is quite a reservoir of BSCE degree holders in the Arkansas Highway Department who are capable and who might desire to pursue graduate study on the Fayetteville campus but who are not in a financial position which would allow them to take an outright leave. Perhaps they could be assigned to one of the Highway Research Projects on the campus on a half-time basis with half of their normal pay coming from the Highway Department without a loss of other indirect benefits. They would carry a normal halftime study load toward a Master's degree and would benefit themselves, the future status of the Arkansas Highway Department, and the Highway Department Research Program on the Fayetteville campus."

From this it is evident that the University will be able to supply personnel of the second type, those who will be suited to conduct the more basic and comprehensive type of research. In addition, the instructor-researcher relationship provides flexibility in personnel resources since it enables the University to assign a person, at least one-half time, to a particular research project as the need for project directors arises.

II. EQUIPMENT: In equipment as in personnel, it should be recognized that applied and basic research require different types of research implements. Applied research can quite often make use of normal operational equipment, and desirably so, since the research methods are closely geared to methods used in routine application of the findings. However, basic research quite often requires special equipment designed solely for laboratory research and, frequently, for only one specific project.

A. Highway Department Equipment: The Highway Department carries a complete inventory of equipment commonly associated with the

operation of a modern highway planning, designing, constructing, and maintaining organization. All of this equipment has been acquired to perform specific functions, none of which are research. The policy of the Department in the past has been to purchase only such equipment as may be needed to perform the routine tasks assigned to the organization. Much of this equipment may be temporarily assigned to a research project on the same basis as the assignment of personnel.

If special equipment is required to conduct a research project it usually can be acquired with funds allocated to the project. Pursuance of this policy enables the Highway Department to establish a flexible research equipment program geared to the needs of specific projects without setting up a separate capital outlay budgetary item. However, this policy does not allow the Department to acquire general research equipment that may be used in the conduct of a wide variety of projects and at present there is no provision in the Highway Department's budget for the purchasing of such research equipment.

B. University of Arkansas Equipment: The University has much of what may be styled, standard academic research equipment, that may be used in the execution of highway research. It should be remembered, however, that this equipment mainly has been acquired to further the education of the students and may not be applicable to specific highway research projects even if it is available. In any event, it must be anticipated that most equipment at the University could be described by the following statement on the condition of equipment in the Civil Engineering Department.

"Much of the Departmental equipment is obsolete and should be replaced by more modern equipment. Other equipment, especially that in use on the Highway Research Program, has been literally worn out by usage during the past 10 years. The budget currently allocated to the Department is barely sufficient to meet day-to-day needs and can hardly be considered for replacement of these items of major equipment. In order to continue our research efforts we must either (1) allocate an overhead allowance on future research, (2) be allocated funds to replace and/or purchase major equipment items, (3) or work out a lease-rental procedure to gain use of this equipment for the duration of a particular project."

Thus it appears that research equipment will be available to the Highway Research Committee on a limited basis at the present; however, there will be a shortage particularly of laboratory and general research implements. On applied research projects it will be possible to overcome most of the equipment limitations but on the more basic projects to be conducted at the University the limitations could be serious.

III. TIME: Time is another of the basic requirements of a research program. In every case, the personnel conducting research must be able to devote sufficient time to the project so that project continuity can be maintained and the results of the project obtained soon enough to be useful.

Time requirements will vary a great deal depending upon the nature of the project. In general, it can be considered that applied research projects can be pursued on a shorter and more flexible time schedule than can basic research.

A. Highway Department Time: It seldom can be planned that a

Highway Department employee will be able to spend more than 25 percent of his time on a research project. However, as brought out in the discussion of personnel, it will be possible for most of the qualified researchers in the Department to devote time to the conduct of research if it does not materially interfere with his routine duties.

This implies that Highway Department personnel's research activities will have to be applied within a relatively short and flexible time schedule which would inherently limit them to applied research projects.

B. University of Arkansas Time: The University has indicated that personnel will be available that can devote at least one-half time to research. These instructors-researchers will usually be able to rigidly schedule their time on research to permit long range and time consuming projects to be undertaken. In addition, the University will be in a position to hire full time researchers and research assistants to work on specific projects.

These time allocation capabilities are mainly indicative of basic research and illustrate that the University's prime contribution of highway research should be in that area.

IV. FUNDS: The last of the primary research facilities to be considered is the funds that may be allocated to financially support the work of the Highway Research Committee. Each of the four basic sources of money that can be identified at this time will be discussed separately below.

A. Highway Department Funds: None of the more than \$35,000,000 in State funds received annually by the Highway Department are specifically budgeted for highway research projects except to match federal funds which will be discussed later. Nor can it be anticipated in the near future that State funds will be set aside solely to finance research projects.

However, as the preceding parts of this report show, the Highway Department has recognized highway research to be a legitimate part of its total operations and has specifically encouraged the development of research by financially supporting the general administration of the highway research program. Thus, it can be anticipated that a major part of the cost of administering the program will be borne by State funds which will, in the end, constitute a significant contribution to highway research.

B. University of Arkansas Funds: Again, none of the more than \$7,000,000 in State funds received annually by the University of Arkansas are specifically allocated for highway research projects. The University does, however, contribute materially to highway research by financing their participation in the "Joint Highway Research Program". This contribution is primarily in the form of administrative expenses and the furnishing of building space, together with utilities and laboratory apparatus.

C. Bureau of Public Road Funds: Federal Highway Statutes provide that one-and-one-half percent ($1\frac{1}{2}\%$) of the total federal highway funds apportioned to the individual states be allocated for the financing of the State Highway Department's Highway Planning Survey (HPS) activities. State highway funds are used to match the Federal HPS funds at the current approximate rate of 70 percent Federal and 30 percent State funds. It is estimated that the Arkansas Highway Department will have about \$800,000 that may be budgeted for HPS work per year with approximately \$150,000 of that set aside for financing specific highway research projects.

It should be noted that the HPS funds currently constitute the only definite source of financial support for specific research projects.

D. Other Funds: Other funds, such as grants from industry, foundations, or public and private agencies will be available for highway research from time to time. However, these funds usually must be expended in compliance with the objectives set forth by the grantor which will not always correspond with objectives of the Highway Research Committee. Thus, these research grants, as substantial and important as they may be, cannot be considered a reliable source of funds from the standpoint of the Highway Research Committee.

It may be concluded that the State Highway Department and University of Arkansas can be expected to support the work of the Highway Research Committee by bearing the expense of administration of the overall program and the individual projects and by providing space and utilities for research. But the funds to support actual work on the individual research projects sponsored by the Committee will mainly come from one source, the $1\frac{1}{2}$ percent HPS Fund.



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