MEMORANDUM
on
A PROGRAM FOR THE EXTENSION OF THE FACILITIES OF THE KETTERING LABORATORY OF APPLIED PHYSIOLOGY FOR INVESTIGATION AND INSTRUCTION IN THE FIELD OF INDUSTRIAL MEDICINE AND HEALTH

Introduction

This memorandum has been prepared in such a manner as to provide merely the outline of facts and circumstances, which, in the opinion of the writer, may be useful in aiding executives of Ethyl Corporation to arrive at a conclusion as to the part Ethyl Corporation should play in the proposed plan. It is anticipated that questions may arise concerning details or additional facts, during the discussion of this matter. The background of the proposal was presented earlier, when, in 1945, the Board of Directors of Ethyl Corporation agreed to appropriate $130,000.00 toward the sum then believed to be required for the purpose. The present memorandum repeats the former only in such matters as would seem to be of major importance, or in those which require brief mention in relation to new conditions. In essence the memorandum attempts to state what is proposed for accomplishment if possible, what facilities are needed to accomplish the intended purposes, what will be the cost of obtaining such facilities, and what advantages may be expected to accrue to American industry, and specifically to Ethyl Corporation, from expenditures made therefor. Suggestions are made as to an appropriate means of proportioning the cost of the enterprise among those who have made contributions toward these ends in the past, as well as those who may reasonably be expected to do so at this time. These suggestions should not be thought of as representing the wishes of the writer or of the University of Cincinnati, with respect to any contributor, but only as one means, which may or may not be the fairest and best.

The writer takes this occasion to express his personal and professional appreciation and that of his associates in the Laboratory and in the University of Cincinnati, for the generosity and the point of view toward the Laboratory and its work, that have characterized the executives of Ethyl Corporation throughout the years. As the recipient of such generosity, and the beneficiary of such a viewpoint, the University and its representatives in this project would indeed be lacking in self-respect and in gratitude if they were to make further appeal to Ethyl Corporation, except in so far as the further financial support of Ethyl Corporation may be expected to be mutually advantageous.

The Present Status of the Laboratory

The growth of the Laboratory since its construction in 1930 has been considerable and steady, with reference to its physical state, in terms of special adaptation and use of space, and its technical equipment, and also as to the size of its staff, the variety, volume and quality of its investigative work, the numbers of industrial organizations that have come to it for assistance, and the size of its annual budget.

Exhibit A (attached) gives some figures which portray the present value of the property in terms of its cost. It will be remembered that the original building and certain of its fixed equipment became available in 1930, through the joint gift of $130,000.00 to the University by Ethyl Corporation ($45,000.00), E. I. du Pont de Nemours and Company ($30,000.00) and Frigidaire Corporation ($55,000.00). Since that time Ethyl Corporation has made direct contributions of aggregate sums approximating $75,000.00 for the building and certain fixed equipment. Part of the latter sum was employed for extensive remodeling to meet the changing needs of

the experimental work ($40,000.00), and part provided an addition to the original building and the installation of special equipment for the study of the physiological effects of flight at high altitudes ($35,000.00). (The latter may be regarded in large part as a direct contribution to the war effort.) Other items of equipment have been purchased from time to time out of the regular annual budget of the Laboratory for supplies and equipment. Funds for such current requirements have been made available by Ethyl Corporation as well as other sponsors of the work of the Laboratory from year to year, and by this means the facilities have been augmented steadily. It can be said, therefore, that every industrial organization that has financed any significant part of the experimental program has made some contribution to the equipment and other operating facilities of the Laboratory. The result has been the development of a remarkably well equipped and highly adaptable laboratory in which a wide variety of experimental work can be conducted with a high degree of convenience and dispatch.

The number and variety of industrial organizations for which the Laboratory has worked is shown in Exhibit B. It is of some special importance, in relation to the present situation, that a disproportionately large number of large organizations have come to us with their problems since 1944. Much of this somewhat sudden interest has been quickened by chemical developments in the wake of the war. We are at a distinct disadvantage here, in that these recently acquired clients, so-to-speak, cannot be expected to provide any large proportion of the funds required for enlarging the Laboratory at this time, since their association with us, in many instances, is too recent to have yielded either proper perspective as to their own future developments, or confidence in the servica-

bility of this Laboratory for their purposes. On the other hand, their coming to us has great significance for the future. It is apparent, from a number of facts that have developed out of these new relationships, that the need for work of this type is very great and quite urgent in many instances, that the facilities available in this country are sadly inadequate, and that this Laboratory, if it were prepared to do so, could increase the scope and volume of its work several fold. It should also be said that because of the dearth of adequate facilities elsewhere, and by virtue of the fact that this is now the largest, best known and best equipped laboratory of its type in this country (now that the Industrial Hygiene Division of the U. S. Public Health Service has restricted its field of work) we have some responsibility to try to meet the present needs of industry, to an extent is compatible with sound organization and proper performance of our job.

The increase in the volume of the work of the Laboratory since its embryonic development in the Richberg Laboratory of Physiology in the College of Medicine in 1925, and extending from its actual founding in 1930 through to the present time, is best portrayed in terms of expenditures made in groups of years, as shown in Exhibit C. It will be seen that the cost of work done on matters of concern to Ethyl Corporation increased from the average annual sum of $17,500.00 during the first four years, to the average annual sum of $55,000.00 for the next ten years, and on to an average of $81,000.00 per year for the next four. The expenditures in this direction decreased in 1945 to $69,000.00 (partly by reason of the pressure of work for others, and partly because one carefully planned program of investigation of lead metabolism came to an end

in the middle of that year), increasing again to the peak of $88,372.00 in 1945. Despite this trend, the work done for other industries has increased at a disproportionately high rate, so that in 1946 only 52 per cent of the expenditures of the Laboratory were incurred in investigative work for Ethyl Corporation. It does not appear from the figures, that the interests of Ethyl Corporation have been neglected while the experimental program for other industries has been expanded. It may be suspected, and is in fact true, that the unit cost of work done for Ethyl Corporation has actually decreased, because of the increasing effectiveness of the research organization. It is also fair to say that the overall quality of the experimental work has increased considerably.

The total expenditures of the Laboratory for experimental work from 1925 through 1946 may be seen to have amounted to a large sum, averaging about $64,000.00 per year, of which 75 per cent was borne by Ethyl Corporation. As seen in the budget for 1947 and its anticipated allocations (Exhibit E), the gross expenditures of Ethyl Corporation are not expected to expand greatly. As a matter of fact, in view of the nature of the work that is under contemplation for the next several years, it seems doubtful if these expenditures should be expanded to any large extent even after certain additional facilities can be provided. The reasons for this statement will appear later.

Exhibit D also serves to reveal the seriousness of the present problem of the work program. The implication that Ethyl Corporation is asking that its experimental program be increased to a level involving expenditures of $101,000.00 is not strictly true, as indicated previously. However, every other sum set down under

"Funds Available" has been provided in the hope that all of the work desired can be done. More funds cannot be accepted because more work cannot be done. Yet it is not to be supposed that all of the industrial organizations represented among the sponsors of work in 1947 will be willing to make large or even small contributions toward the provision of further experimental facilities. Some of them are known to be planning laboratories of their own for such work and are anxious to have our help meanwhile. We believe these plans for privately operated laboratories to be unwise, excepting as the scope of the work is limited to problems of industrial health among the employees of the industry concerned. Even under these circumstances, such work, when carried out effectively, is unduly expensive and is generally wasteful, since the results arerarely published and thus the work is likely to be replicated in a number of such laboratories. In our opinion, the building up of hygienic information for the general use of industry by the application of sound experimental methods which are subjected to open examination and appraisal, is badly needed, and considering the generallack of adequate facilities to this end, every effort should be made to avoid duplication of effort and inefficiency in the employment of funds and facilities. However, we cannot oppose or discourage the efforts of industrial organizations to solve their own problems of this type, nor can we influence the present trends except by our own more adequate response to current needs. There is adequate evidence, however, that such facilities as we can obtain will be employed to the fullest extent in the immediate future and for a long time to come.

Medical Education and the Laboratory

Coincident with the growing need for investigative work in industrial hygiene in our rapidly expanding industrial community, there is urgent necessity for the training of practicing physicians, (to a lesser degree, engineers). This need has been recognized for some time, and some efforts are being made in university and industrial circles to meet it. Unfortunately, in our opinion, most of these efforts are being made by persons and groups lacking experience either in the field of medical education or in that of industrial practice. Any program of instruction that is to be effective must meet the practical needs of the day's work within industry, but must also be built upon the firm foundation of modern medical training and research. We cannot ignore our responsibility in this University for working out and executing a program of training that will produce medical men with the special knowledge and skills that are required. We expect to do this on a small scale, and in such manner that the experimental and clinical facilities of this laboratory and the varied general educational facilities of the Colleges of Medicine, Engineering, Law, and Business Administration in the University, will serve our purpose. Our associations with our colleagues in these faculties of the University are such that this can be done, and the plan now visualized can be carried out without encroachment upon the space and equipment designed for investigative purposes. Moreover the expense of this work, as we have planned it initially, will be negligible. Special funds will be required only for establishing fellowships, with stipends to individuals for two years in succession. These will not exceed $3,000.00 per person per annum, and will be limited to two for the first year. We have reason to believe that a number of industrial

the development of personnel with special training in this field. These stipends are larger than those granted to undergraduates and to certain types of graduate students, but we shall accept only persons who have completed their medical training together with two years of hospital experience. Such men will rarely be able to continue further training on their own resources, and many of them, over any considerable period of years, will be married. They cannot be expected to make more prolonged and more serious economic sacrifices for the sake of this highly specialized training. On the other hand, we have found it possible to obtain the right kind of applicants for fellowships of the type specified. Two have been offered as follows:

	Single Persons	Married Persons
First Year	$2,100	$2,700
Second Year	2,400	3,000

A third year in an industrial service or in a series of such services (on salary) is planned to fulfill the need for practical experience. During this period the work will be carried out under the joint responsibility of the University and the Medical Staff of the industrial organization, in much the same fashion as a hospital residency is authorized and conducted.

Some adjunct instruction for engineers is contemplated, in a working relationship with the College of Engineering, but the means by which this is to be done have not been worked out as yet. Our rôle in such a plan is likely to be minor, and will involve only some expenditure of time.

The Plan for Expansion

A former memorandum indicated our belief that the laboratory building should be enlarged to approximately twice its present size,

by the elongation of the present short wing which is on the ground floor only, and by adding three floors above this level, so as to complete a substantially symetrical building of two wings at right angles to each other. In this space the additional laboratories now needed could be housed, together with the clinical facilities (on the ground floor) that are badly needed, as well as the animal quarters (on the top floor and roof) without which the general experimental program cannot be augmented. The enlargement of the building to this extent was believed necessary, not so much to double the work as previously conducted, as to augment it in those respects in which it is found to be most lacking. Certainly the staff of the Laboratory, which now numbers fifty-seven, will not be greatly increased, since most of the projected space would be occupied by the present staff if it were available. Present work is considerably handicapped by the shortage of office space, among other things. Storage space is almost non-existent. Certain laboratories are overcrowded with equipment and personnel. Indeed, the effort has been made during the past several years to increase the staff as the growth of the work required, and to adapt the available space, at whatever inconvenience that might result to individuals, to the necessities of the situation. There can be no doubt that this procedure has reached the point of diminishing returns in a number of respects. While it could be justified as a temporary necessity, it cannot be continued much longer without serious consequences. Therefore, we shall have to expand the laboratory to conduct even the present volume of work, and if we are to turn out more and better work, our requirements cannot be reduced much below the level contemplated in our original plan.

Following approval of the plan, which, as originally proposed in 1944, involved tentatively estimated expenditures of $200,000.00,

building) drew up final plans and specifications in accordance with our carefully worked out requirements. These plans differ from those prepared for the original structure, in that what is needed at this time, with but few exceptions, can be set down in detail and with precision, without prejudice to a very considerable flexibility. In large part, and certainly in those respects in which our needs are greatest, the completed space can be put to use at once, the necessary services and facilities being brought to completion, instead of being brought to a convenient point for subsequent application. Certain of these service facilities could be held in abeyance for later development if this turned out to be entirely necessary, but not, we believe, without curtailment of the contemplated program of experimentation, and not without some degree of unnecessary expense at a later date. An appreciable decrease in the cost of materials and of labor at some later time might offset this disadvantage, but such a circumstance is not predictable. In any case the plans and specifications, as now available, have been used as the basis for builder's and contractor's estimates (not bids). It is no surprise, in view of the events of the past two years, that these estimates are outrageously high. The facts are summarized briefly in Exhibit E. (The plans and specifications for the new building and its various services are also available for examination.) It is believed by the architect that the situation in the building trades in Cincinnati has stabilized to some degree since these estimates were made, and that the cost will be somewhat less than that indicated here. It is also believed by the architect and by the writer, that certain costs established by present specifications can be materially reduced by the re-examination of the specifica-

tions, item by item, and by substituting less costly but not less satisfactory materials, so far as they are obtainable. There is little extravagance in the specifications, but there is some, we think, and these can be eliminated, with savings which may range from $25,000.00 to $50,000.00. This has not been done, for the reason that neither we, nor the architect, wish to spend further effort and time upon these plans, until some decision has been reached as to what general course is to be followed.

The great increase in the cost of carrying out our plans has made it necessary to reconsider our entire program. We believe that we should not postpone our efforts, for reasons indicated previously. On the other hand if we are to go ahead at this time, it would seem that the cost of the enterprise must now be shared by a larger number of industrial organizations. For this reason, we have now done what we formerly hesitated to do, having approached all but a few of our most recent sponsors, inviting them to share in the creation of the additional facilities necessitated in part by their requests for assistance. The responses to these approaches have been generally reassuring. The actual appropriation of funds has not been accomplished to the degree which justifies a full statement of the situation at this time. However, the allocations represented in Exhibit F are based partly upon receipts of contributions, partly upon pledges, partly upon reasonable expectations and partly upon hope. This Exhibit as here presented will be corrected and made factual as to the status of each item, as events permit. It is not too far from the truth to be employed as the background on which the judgment and advice of executives of Ethyl Corporation can be based.

Thought has been given to other means of financing some portions of this project. It was thought at one time that certain

charges could be assessed against each project accepted hereafter from organizations not listed among the contributors to this fund. By such means funds might be accumulated and employed as required in the future for obtaining additional space and equipment, or for retiring obligations incurred at this time. On careful consideration of this procedure, some considerable doubt may be entertained as to whether it is in keeping with the policies and legal rights of this University. Certainly the Director of the Laboratory cannot authorize or carry out such policy without the approval of the Board of Directors of the University. Our definite impression is that such approval would not be granted. Certainly this would be the case in relation to our assumption of financial obligations for later retirement whether privately or with the official backing of the University. We could encourage and even solicit contributions toward endowment funds, but obviously these could not be made a condition to our acceptance of problems for investigation, either directly or by subterfuge. For these reasons we incline to the opinion that we should accept the decision of our present sponsors as to the degree of feasibility of our present program, adapting ourselves thereto, without other commitments or present reservations as to future developments. This opinion represents a reversion to a former viewpoint, which, from the University aspect would appear to be sound - namely, that our work is determined, in large measure, by the recognized needs and interests of the industries served, and that we should live within the means so provided, until and unless other and independent means come to be available. This then is the present position, on the basis of which the good advice of executives of Ethyl Corporation as to our best course at this time, is needed and sought.

The Status of the Laboratory in Relation to Ethyl Corporation and Its Hygienic Problem

There remains only the necessity for presenting the facts as to the services now being rendered by the Laboratory to Ethyl Corporation, as well as those which seem to be required in the future. Here, in effect the writer must divorce himself, so far as possible, from his concern for the present and future of medical education and research as a member of the faculty of the University of Cincinnati, and consider as realistically as he may, his professional responsibilities to Ethyl Corporation. Regardless of whether this can actually be done, it is necessary to bring to the attention of the Executive Committee various phases of the work of the Laboratory which are carried out for Ethyl Corporation, as well as certain additional problems which seem to require further careful investigation.

In exhibit G are listed a series of items of work carried out in the year 1940, by members of the staff of the Laboratory. It should be recognized that these items of work and the expenditures made in their performance, are entirely separate, administratively and otherwise, from the regular work of the physicians of the Medical Department of Ethyl Corporation. These things are done by the University of Cincinnati, on the request, so-to-speak, of the Medical Director of Ethyl Corporation, and at the expense of Ethyl Corporation, in exactly the same manner, theoretically, as such work would be done for any other acceptable industrial organization. Every service that is commonly rendered by the Laboratory to Ethyl Corporation from year to year is represented here in more or less characteristic form and quantity, with the exception of the provision of office space for the conduct of the medical affairs of Ethyl Corporation. If the two

fessional and clerical staff of the Medical Department would require space, office and medical equipment and various services in duplication of the facilities now available in the Laboratory. From time to time we have considered that it might be advisable to have such a separation of activities. Lately we have come to the conclusion that any serious criticism of our somewhat complex professional activities would probably be the result of malice rather than misunderstanding, and would therefore be unavoidable in any case. An examination of the items of Exhibit G discloses some rather unusual and scattered ramifications of the business of Ethyl Corporation with respect to toxic hazards, whether actual or suspected. It is of some interest to recognize that the contacts of the Laboratory with various aspects of the highly organized commercial life of the community are numerous and varied, thereby giving us a considerable awareness of many matters that seem to be of small importance but may turn out to have real significance.

Without question the more valuable services of the Laboratory to Ethyl Corporation are represented in Exhibit H. It is in this field of investigation that we have been enabled to sound out the future, so-to-speak, and to obtain the basic information on which to base long-term policies in relation to the safety of the public, and that of the employees of Ethyl Corporation who are engaged in hazardous work. At another time and for another purpose, the several items of this Exhibit might well be commented on in some detail. Suffice it here to list them in reasonably understandable terms as the basis for demonstrating that extensive investigation has been required for the purpose of dealing with current and long-range hygiene problems of the Corporation.

It might be thought that the program of hygienic investi-

gation could be reduced progressively from some time in the near future onward. This, it should be said with emphasis, cannot be done except at considerable peril. The commercial activities of Ethyl Corporation do not stand still, nor do the industries so closely related to Ethyl Corporation remain quiescent. New problems are created every time a distributor of petroleum elects to employ new methods of producing or marketing a product which contains tetraethyl lead or any other lead compound. New potential hazards of unknown significance are created by changes in the design of motors and motor cars, and by different procedures for servicing, repairing and operating them. Most of such changes are insignificant in their effects, but one never knows when some significant move will be made. These are matters of minor importance, however, when the narrowness of the present margin of safety in the matter of public lead absorption is recognized. Certain facts will serve to illustrate the point. We have been studying the sources and the order of magnitude of the lead intake of the ordinary normal person in this and other countries for many years, partly because of interest in the problem, of course. It is a fascinatingly complex biological problem. However, we should have been unable to justify the expenditures made on behalf of Ethyl Corporation, in all honesty and fairness, if we had not been convinced that this is the key to the manner of conducting the business, so far as its relationship to the public health is concerned. If and when there should be reasonably acceptable evidence of danger to the public, additional safeguards would have to be created. Recently we completed an elaborate study, of several years duration, of the fate of lead taken in with food and beverages. Many significant facts were established, but the important one for present purposes relates to the amounts of lead which can

safely be taken in with the food every day over a period of many years by the healthy adult. This is of the order of magnitude of half a milligram of soluble lead. Actually the mean value of that which is taken in with the food and drink of the average American is three tenths of a milligram. The importance of these facts is very great, and on account of them we have concluded that we must determine the significance of inhaled lead with the same care we have applied to the solution of the other problem. This will require some years of study, but we now know that under present conditions the lead in the atmosphere breathed by certain segments of the population is of the order of magnitude of one tenth of a milligram per day. It seems reasonably certain that this situation has changed but little within the past decade or two, but the operating factors, including the concentration of lead-containing exhaust gases discharged into the atmosphere, which may influence this situation, are numerous and varied. The combustion of coal and wood, the distribution of smoke and soot, and the proximity of highways and industrial plants to population masses are all factors. The facts in these matters, and the manner of disposition of the inhaled lead in the body, should be known in some detail. We propose to establish the facts, because we believe the safety of the public is involved. We also believe that Ethyl Corporation needs to know these facts,because the manner of conducting its business is involved. If there is actual danger, or an unduly low margin of safety, we shall be the first to know it, and Ethyl Corporation will be fully advised. Moreover, by following the course we have laid out we will be the source to which public health authorities and others will be bound to come for information. There is no question about our present status as investigators of this

subject, and if we maintain our prestige by hard work, rather than by professional or academic self assertion, we shall be able to maintain and consolidate this status. The importance of this in relation to inspired or misguided measures which might do serious harm to the industry, may well be considerable.

It may be remarked in passing, although it is of more than incidental importance, that the information which enables us to appreciate the public position, with respect to lead hazard, will also, as in the past, provide us with the means of protecting the employees of Ethyl Corporation and those of its customers against the hazards of their occupations.

In calling attention to the foregoing matters, we do not take the attitude of the alarmist, but rather that of the realist, who undertakes to foresee the worst that can happen and to set up suitable means for offsetting it. In this instance, "the worst" is not conceived of in wholly imaginary terms, but as certain "probabilities" (in the technical sense) based upon known facts, the full significance of which cannot be appreciated without further investigation.

The experimental work contemplated in connection with the general problem referred to above, will be approached systematically and spread over a period of years. By this means it will not assume the character of urgency, and it will be fitted into the general experimental program of the Laboratory. Its cost will be kept at a moderate level thereby, and will be spread over some period of time. We consider this good policy in relation to both Ethyl Corporation and the Laboratory, in the latter instance because a continuing large and well-financed item of work contributes greatly to the

social and economic stability of the Laboratory.

Concluding Statement

The foregoing paragraphs represent our viewpoint on this entire situation in fairly comprehensive outline. Our request, for our own guidance, is that the Executive Committee of Ethyl Corporation determine what investment the Corporation should make toward this project, out of broad consideration of its own interests. We have considered the problem from many aspects, and have been somewhat too deliberate perhaps in our presentation of it. For many reasons, it is important that there be no further prolonged delay in arriving at a decision. We are prepared to plan our course on what can reasonably be done at this time. As the large contributor in the past, and as the largest single sponsor of the current experimental program of the Laboratory, the action of Ethyl Corporation will be decisive. However, we feel strongly that this fact should not be permitted to exert an undue influence upon the decision. Our concern for the Laboratory is that it should fulfill an important purpose over a long period of time. This can be accomplished only if it builds upon the firm foundation of the actual needs of its industrial sponsors. Any such sponsor, convinced against better judgment, or led by other means to contribute beyond its recognized desire, will probably withdraw his support one day. The writer hopes to have no part in bringing about that day.

Robert A. Kehoe

Robert A. Kehoe, Director

April 4, 1947

Kettering Laboratory of Applied Physiology, College of Medicine,
University of Cincinnati

EXHIBIT A

FINANCIAL DATA

KETTERING LABORATORY OF APPLIED PHYSIOLOGY, COLLEGE OF MEDICINE, UNIVERSITY OF CINCINNATI

Approximate Value of Property in Terms of Cost
(Building and equipment have been maintained in excellent condition by careful supervision and replacement. The cost of maintenance, replacements of equipment and additions to equipment has been reflected in operating costs, which have been distributed among contributors to all experimental projects during the past ten years. Replacement value of property now greatly appreciated.)

Building and fixed equipment	[illegible]
Other operating equipment, office fixtures and library facilities	[illegible]
Total	[illegible]

Approximate Distribution of Cost of Above Facilities

Ethyl Corporation	[illegible]
Other Contributors	[illegible]

KE 0014245

EXHIBIT B

CONTRIBUTORS TO THE EXPERIMENTAL WORK OF THE LABORATORY

from 1930 to the end of 1947

Ethyl Corporation
E. I. du Pont de Nemours and Company
Monsanto Chemical Company
Frigidaire Corporation
Commercial Solvents Corporation
Chicle Development Company
Standard Alcohol Company
Mead Johnson Company
Eagle Picher Lead Company
Dow Chemical Company
Lowe Brothers Company
C. F. Kettering Foundation
Harrison Radiator Division of General Motors
Procter and Gamble Company
Graselli Chemical Company
Hilton-Davis Company
Remington Arms Company
U. S. Government (Office of Scientific Research and Development, Committee for Medical Research, Quartermasters Department, Army)
Kenton Pharmacal Company
B. F. Goodrich Company
Pennsylvania Salt Manufacturing Company
American Cyanamid Company
The Geigy Company
Parke-Davis Company
The Texas Company
Hooker Electrochemical Company
Universal Oil Products Company
Wright Aeronautical Corporation
Johnson Bronze Company
The Institute of Paper Chemistry
The Lithographic Technical Research Foundation
The Barrett Division of Allied Chemical and Dye Corporation

Since 1944

Standard Oil Development Company
Standard Oil Company of Indiana
Professional Cold Wave Manufacturers Group
Armour and Company
Swift and Company
American Petroleum Institute
Lehman Brothers
C. P. Hall Company
Mallinckrodt Chemical Works
Purdue Research Foundation
Wyandotte Chemicals Corporation
Velsicol Corporation
U. S. Government (Public Health Service)

Reynolds Metals Corporation
Aluminum Company of America
Hamilton County, Ohio - Coroner's Office

EXHIBIT C

FINANCIAL DATA

KETTERING LABORATORY OF APPLIED PHYSIOLOGY, COLLEGE OF MEDICINE, UNIVERSITY OF CINCINNATI

Operating Cost of Laboratory From Time of Origin to Present Time

Cost of Experimental Work carried in Physiology Laboratory College of Medicine, from 1925 to 1930	$70,000.00
Cost of Experimental Work carried out in Kettering Laboratory, from 1930 through 1946	1,337,140.67
Total Cost of Experimental Work	$1,407,140.67

Approximate Distribution of Cost of Experimental Work

Prior to 1930	Cost	Percentage
Ethyl Corporation	$70,000.00	100
1930 through 1940		
Ethyl Corporation	507,500.00	82
Other Sponsors	82,800.00	13
1941 through 1944		
Ethyl Corporation	324,249.11	59
Other Sponsors	228,938.53	41
1945		
Ethyl Corporation	69,458.66	48
Other Sponsors	74,094.37	52
1946		
Ethyl Corporation	88,372.00	52
Other Sponsors	83,755.79	48
1925 through 1946		
Ethyl Corporation	1,071,307.77	76
Other Sponsors	335,832.90	24
	$1,407,140.67	100

EXHIBIT D

FINANCIAL DATA

KETTERING LABORATORY OF APPLIED PHYSIOLOGY, COLLEGE OF MEDICINE, UNIVERSITY OF CINCINNATI

Estimated Cost of Experimental Program 1947

Budget Estimate

Salaries	$ 17,[illegible].00
Other	41,2[illegible].00
	$ 711,2[illegible].00

Estimated Distribution of Available Funds and Operating Costs

Sponsor	Funds Available	Probable ** Expenditures	Percentage of Tot. Exp.
Ethyl Corporation (Lepore)	$ 11[illegible].00	$ 7[illegible].00	[illegible]
E. I. Du Pont de Nemours and Co.	1[illegible].00	1[illegible].00	[illegible]
Monsanto Chemical Company	[illegible].00	1[illegible].00	7.[illegible]
Commercial Solvents Corporation	1[illegible].00	[illegible].00	[illegible]
E. I. Goodrich Company	1[illegible].00	1[illegible].00	[illegible]
Pennsylvania Salt Manufacturing Co.	[illegible].00	[illegible].00	[illegible]
American Cyanamid Company	1[illegible].00	1[illegible].00	[illegible]
The Gulf Company	1[illegible].00	1[illegible].00	[illegible]
Universal Oil Products Company	[illegible].00	[illegible].00	[illegible]
Institute of Vector Genetics	[illegible].00	[illegible].00	[illegible]
Standard Oil Development Company	1[illegible].00	[illegible].00	[illegible]
Standard Oil Company (Indiana)	[illegible].00	[illegible].00	[illegible]
Professional Lab. Five Manufacturers	[illegible].00	[illegible].00	[illegible]
Armour and Company	1[illegible].00	1[illegible].00	[illegible]
Swift and Company	1[illegible].00	1[illegible].00	[illegible]
American Petroleum Institute	1[illegible].00	[illegible].00	[illegible]
Lehman Brothers	[illegible].00	[illegible].00	1.[illegible]
Hallinckrodt Chemical Works	[illegible].00	[illegible].00	1.[illegible]
Purdue Research Foundation	[illegible].00	1[illegible].00	[illegible]
Wyandotte Chemicals Corporation	[illegible].00	[illegible].00	[illegible]
Reynolds Metal Corporation	[illegible].00	[illegible].00	1.[illegible]
Aluminum Company of America	[illegible].00	[illegible].00	1.[illegible]
Sylvania Electric Products, Inc.	1[illegible].00	7[illegible].00	[illegible]
Velsicol Corporation	1[illegible].00	[illegible].00	[illegible]
Hamilton County Coroner	1[illegible].00	[illegible].00	[illegible]
U. S. Government (U.S.P.H.S.)	1[illegible].00	1[illegible].00	[illegible]
Totals	[illegible].00	$711,[illegible].00	[illegible]

* Available in terms of agreements to prosecute work as rapidly as possible. More funds readily available if desired work could be done.

** Probability based upon extent of ability to perform work in research facilities with present personnel.

EXHIBIT E

FINANCIAL DATA

KETTERING LABORATORY OF APPLIED PHYSIOLOGY, COLLEGE OF MEDICINE, UNIVERSITY OF CINCINNATI

Estimated cost of additional facilities by architect in December of 1944, on basis of informal discussion of probable requirements		$250,000.00
Estimated Cost of additional facilities by architect in September 1946, after completion of plans and specifications for building and specialized fixed equipment (air conditioning, etc.) as worked out in detail with staff of Laboratory		
Builders estimate (outside) including fixed fee of $20,000.00		$ 95,000.00
Other branches of work closely estimated as follows:		
Electrical	$ 39,000.00	
Air Conditioning	48,000.00	
Heating and Ventilating	60,000.00	
Plumbing	20,000.00	
Elevators and dumb waiter	4,000.00	
	171,000.00	
Adjustment clause 10%	17,100.00	188,100.00
Total		$283,100.00
Architect's fee (on his estimate of $)		24,000.00
Grand Total		$307,100.00
Estimated cost of remodeling present building (can be deferred)		10,000.00
Estimated cost of additional operating equipment in new building		45,000.00
Total to complete facilities		$512,100.00

EXHIBIT F

FINANCIAL DATA

KETTERING LABORATORY OF APPLIED PHYSIOLOGY, COLLEGE OF MEDICINE, UNIVERSITY OF CINCINNATI

Suggested Distribution of Cost of New Facilities Among Industrial Sponsors, based upon approximate proportional use of all facilities of Laboratory from 1944 through 1947, or in subsequent years so far as can be ascertained.

Total not to exceed $500,000.00#

Sponsor	Percentage	Contribution
Ethyl Corporation	60	300,000.00*
Monsanto Chemical Company	5	25,000.00
E. I. Du Pont de Nemours and Company	10	50,000.00**
Commercial Solvents Corporation	5	25,000.00
Hilton-Davis Company	1	5,000.00
The Texas Company	2	10,000.00***
Universal Oil Products Company		1,000.00
Barrett Division of Allied Chemical and Dye Corporation	2	10,000.00***
Miscellaneous Recent Sponsors -		
B. F. Goodrich Co.		
Wyandotte Chemicals Corp.		
Geigy Company, Inc.		
Standard Oil Co. (Ind.)		
Standard Development Co.		
Mallinckrodt Chemical Works		
Aluminum Company of America	9	45,000.00***
Total regarded as adequate if present program is followed		$471,000.00

$12,000.00 available from anonymous contributor.

Unmarked sums received or formally appropriated.

* $130,000.00 of this sum previously appropriated.
** $15,000.00 of this sum received - balance unsolicited as yet.
*** Under consideration at present. Size of individual contributions uncertain.

EXHIBIT C

KETTERING LABORATORY OF APPLIED PHYSIOLOGY, COLLEGE OF MEDICINE, UNIVERSITY OF CINCINNATI

Nature, scope and approximate cost of routine services rendered in the course of a typical year (1945) in obtaining necessary information for the detection and control of current hazards of business operations of Ethyl Corporation

ITEMS	ACTUAL COST $
1. Lead analyses in connection with the operation of Baton Rouge T.E.L. Manufacturing plants	
(a) Quarterly samples of feces and urine obtained from representatives of all occupations (approx. 600)	2,000.00
(b) Spot samples of blood and urine in connection with regular examination of all employees of lead area (approx. 1000)	2,000.00
(c) Spot samples of urine and blood from smelter personnel (approx. 500)	1,000.00
2. Lead analyses in connection with the operation of the research and testing laboratories of Ethyl Corporation	
Samples of feces and urine (approx. 200)	1,000.00
3. Lead analyses obtained in connection with diagnostic problems met in field by the staff of the Medical Department of the Ethyl Corporation among blenders, persons exposed to leaded gasoline with complaints or allegations of injury (approx 150)	500.00
4. Lead analyses of sludge, scale and other materials obtained from tanks and other containers employed in the transportation and storage of gasoline (approx. 100)	500.00
5. Lead analyses of materials from all parts of country, including food products, edible oils and drinking water sent in by individuals, commercial organizations, and field representatives of Ethyl Corporation (approx. 200)	1,000.00
6. Consultation advice in connection with a wide variety of problems related to leaded gasoline, posed by industrial organizations, governmental and military organizations, private individuals and public officials. Opinions and advice based on experimental evidence with or without interpretations of specific analytical data	

at time. Approximate value of time (not less than 1/5 of total time)	$ 1,000.00
f. Microscopic examinations of blood films obtained by physicians of Medical Department of Ethyl Corporation in course of regular periodic examinations of mixing personnel	4,000.00
g. Clinical microscopy by Kettering Laboratory technical staff (not physicians) carried out in connection with examination of Ethyl Corporation and Ethyl Specialties personnel who came to Cincinnati for examination or consultation	500.00
h. Statistical work in the study and interpretation of analytical data obtained from routine and special lead analyses on operating personnel of Baton Rouge Manufacturing plants	1,500.00
Total cost of routine services	$ 25,000.00

EXHIBIT H

KETTERING LABORATORY OF APPLIED PHYSIOLOGY, COLLEGE OF MEDICINE, UNIVERSITY OF CINCINNATI

Nature, scope and approximate cost of experimental programs carried out in connection with immediate or long-term problems or developments of Ethyl Corporation bearing upon industrial or public health, during a typical year (1946)

ITEMS	ACTUAL COST $
1. Systematic investigation of certain phases of the behavior of lead in the human organism, and the problems of lead absorption, distribution and excretion in relation to lead poisoning	
(a) The threshold of safety with respect to the ingestion of lead with food and beverages from day to day, on the part of normal individuals, as part of the background of the business of Ethyl Corporation in its relation to the health of the community (1 subject studied in 1946)	15,000.00
(b) The fate of lead absorbed during occupational lead exposure, in terms of the rate of progressive elimination and the means of altering the rate (approx. 4 patients studied)	4,000.00
(c) The therapy of lead poisoning	
(1) Effects of the administration of ammonium chloride	
(2) Effects of the administration of potassium iodide	
(3) Effects of the use of B.A.L. (6 patients studied)	4,000.00
(d) Clinical and laboratory diagnosis of lead poisoning - miscellaneous work in study of lead poisoning in children and adults	2,000.00
2. Investigations of the toxicity of certain halogenated hydrocarbons employed or considered for employment in the manufacture of antiknock compounds - 2 compounds studied cursorily in 1946	2,000.00
3. Investigation of the toxicity and mode of action	

of certain amines and other incidental chemicals employed in manufacturing processes in the Baton Rouge plant of Ethyl Corporation - 2 materials examined in preliminary manner

4. Investigation of the toxicity, mode of action of Xylidine and monomethyl aniline, and of the practical hazards of their use as antiknock compounds in motor fuels. (Completion of fairly comprehensive work begun on behalf of Ethyl Corporation and Associated Ethyl Co. Ltd. during the war.)

4. Investigation of the immediate toxicity of certain detergents for use in Ethyl Cleaner for Ethyl Specialties Corporation

5. Investigation of the effects of contact of human skin with Ethyl Cleaner and its constituents (23 human subjects studied in 1946)

6. Investigation of the cutaneous irritant properties of impermeable gloves developed for use by Ethyl Corporation research laboratories in the E.K.L. manufacturing plants and elsewhere - (66 human subjects studied in 1946)

7. Library work in literature research and compilation of bibliographies, by library staff and members of research staff of Laboratory (about 8 separate items of work of variable size and scope in 1946, together with systematic accumulation and classification of references and reprints on lead compounds, halogenated hydrocarbons and detergents)

8. Investigation of analytical methods for lead in biological materials, including a short screening method for diagnostic purposes, and the determination of radioactive isotopes of lead

9. Investigation of the distribution of lead and certain other materials (Bromine) in the air of Cincinnati in relation to various environmental factors, including automobile and aeroplane exhaust gas. (Begun in October)

Total Cost of Investigative work, with exception of certain overhead costs, including those of top supervision and administration