

CONFIDENTIAL

Memorandum on the General Scope of An Investigation to
Appraise the Potential Hazards Associated With the Commercial Exploitation
of Motor Gasoline Containing Tetramethyl Lead.

The impending distribution of gasoline containing tetramethyl lead on the West Coast provides an opportunity to plan, in advance, a program of investigation which will demonstrate the existence or non-existence of hazardous absorption of lead in association therewith. Inasmuch as the industries involved in this new development in the field of antiknock motor fuel must not remain in any doubt on this score, and since they are also prepared to provide satisfactory evidence concerning it to the United States Public Health Service, as recommended by the latter, a plan of investigation is required and is outlined herein. Such modification of this proposed plan as may be found to be necessary either to improve upon it or to suit it to the conditions which are to exist, will be the subject of further discussion. It is not intended to be a final or unalterable plan of procedure to be pursued in an undeviating manner, but rather to cover the ground which, in fact and principle, is worthy of exploration.

It has been established beyond doubt that an essentially uniform occupational exposure to lead compounds (that is, a type of exposure that exists during the hours of work only, approximately 8 hours per day on 5 days per week), results in a progressive increase in the rate of the urinary excretion of lead (and, except for the organo-metallic compounds of lead, in the level of lead concentration in the blood) over a period of 6 to 8 months, after which a maximum is reached at a level which characterizes and delineates the severity of the exposure. On this account we shall be able to demonstrate

the significance, if any, of the occupational exposure to lead of the handlers of gasoline containing tetramethyl lead, within a year, quite as well as this could be done in several years. Thus the investigation of this problem over a period of approximately one year, and the preparation of a report at the end of that time, should settle the matters that are in doubt in a substantially final manner. It is important, therefore, that this investigation be done with adequate scope and precision. Some unusual situations may be encountered in such an investigation as is outlined here. For example, there may be some unexpected disadvantages or advantages in the use of tetramethyl lead in relation to the somewhat complex problem of the precise behavior and fate of the primary organo-metallic compounds in gasoline storage tanks of large volume.)

The mandate is that of conducting "studies that would demonstrate (the) acceptability (of gasoline containing the appropriate amounts of tetramethyl lead) from the public health standpoint." Inasmuch as the exposure to lead from this source, on the part of the public, is certain to be less than that of persons who will engage regularly in certain occupations (indicated hereafter) involving the handling and use of gasoline containing tetramethyl lead, it is incumbent upon us to determine whether any of these regular occupations give rise to hazardous absorption of lead. By so doing, if the investigation yields negative results, we shall have demonstrated the safety of the public, and if, on the other hand, we should demonstrate that the ordinary handling of gasoline containing the appropriate concentrations of tetramethyl lead is ultimately dangerous, in terms of lead absorption, the use of tetramethyl lead for antiknock purposes will have to be abandoned. In any case, an adequate answer to the present question of the feasibility of the continued use of tetramethyl lead as an antiknock additive to motor gasoline will have been secured. A preliminary investigation has yielded a

partial answer to this question - one which is lacking in adequacy only in respect to the influence of the factor of time, concerning which the observations require extension, as indicated above.

A further request of the Public Health Service, directed to the industries involved, relates to the preparation of a report "to the Public Health Service, one year after initiating the substitution (of TML for TEL), on the impact of TML on the contamination of the atmosphere in a major population center, as well as clinical and environmental data demonstrating the (degree of) safety --- in the manufacture, use and handling of TML and of gasoline containing this compound." This report, as indicated above, should be sufficiently comprehensive to serve as a document which can be submitted not only to the U.S. Public Health Service, but also to other agencies and authorities that have legal or professional responsibility for occupational and public health in the United States of America and elsewhere.

Outline of Investigation

1. General Scope.

The program of investigation contemplated for the fulfillment of the requirements must include a fairly comprehensive examination of the environmental conditions, with respect to the extent of the contamination of the atmosphere with the vapor of tetramethyl lead (1) in the plant or plants in which tetramethyl lead is manufactured commercially; (2) in representative installations in which antiknock fluids containing tetramethyl lead are mixed with gasoline to produce commercial gasoline; (3) in refineries or terminals in which gasoline containing tetramethyl lead is handled in bulk or introduced into mobile equipment or into other containers for distribution; (4) at service or filling stations where gasoline is dispensed into the fuel tanks of automotive

vehicles; and (5) in garages in which trucks and automobiles are supplied with fuel and with various services of maintenance.

The program must include clinical examination of representative groups of personnel engaged in the usual operations in the various sites and occupations indicated above, initially and at reasonable and appropriate intervals, thereafter.

It must also include the collection and analysis of samples of the urine and blood of the persons subjected to the clinical examinations, at the time of the performance of the examinations (and at other intervening times if and when this can be done advantageously for statistical or other purposes.)

In order to include within the scope of the investigation such variables as (1) climatic conditions, (2) occupational conditions, facilities, and performance, (3) non-occupational environmental factors, and (4) representative factors relating to personal health and hygiene within the groups of persons to be investigated, the geographic and numerical base of the investigation should be distributed as widely as is both possible and practicable. Likewise, for statistical purposes, i.e., for the inclusion of purely fortuitous variables and the recognition of genuine correlations, sufficient numbers of observations must be made over a sufficient period of time to reveal definitive effects or the lack of such effects.

2. The Selection of Experimental Sites and Personnel.

Preliminary consideration has been given to the choice of available sites, following the general conference on the subject on March 10th in which the undersigned expressed his wish to visit the proposed sites in person and to consider their relevance at first hand (it will not be necessary for me to visit all of the proposed sites, since Mr. Cholak, who has had extensive

experience in these matters, is to supervise the environmental survey of the installations of Standard Oil of California as well as the service stations and garage(s) selected for investigation.)

(1) Manufacturing plant.

So far as is known, commercial manufacturing operations (TML) are now being carried out only at Baton Rouge, Louisiana. The regular environmental and medical regimen of this plant is adequate for the purposes of the hygienic appraisal of the relative disadvantages or advantages of the manufacture of TML as compared with TEL. The results of air analyses, periodic medical examinations, and the analyses of the urine and blood of the employees will be assembled for the purpose of reporting fully on this aspect of the matter. Mr. Cholak and the undersigned will confer with the appropriate personnel in order to make sure that these data shall be obtained and assembled in a suitable manner. If it should develop within a twelve-month period in 1960 - 61, that there are other commercial manufacturing operations, steps will be taken to obtain for the record, and to report, any and all information that would appear to have a bearing on hygienic matters.

(2) Plants in which tetramethyl lead is mixed with gasoline.

The only available installations of this type are at refineries (or bulk terminals?) of Standard Oil Company of California. It seems sufficient now (subject to reconsideration on the basis of better and more direct information) to confine this part of the investigation to four plants that appear to present sufficiently variable conditions of climate and operation. Certain other installations seem to be less important because of the limited numbers of their employees or because there seems to be nothing unusual in their operations. The sites selected are at the Richmond, Bakersfield, El Segundo and El Paso refineries. The men involved in these

operations number approximately 14, 15, 14 and 8 respectively, thus providing around 50 persons altogether, a sufficient number for the purpose. (Only 1 man is involved in Salt Lake City, and while the number of men so employed in Vancouver is sufficient to justify the inclusion of this group, there seems little point in so doing unless the operations or the conditions surrounding them are found to vary appreciably from those at the refineries listed above. This situation, however, is worthy of careful consideration, since there should be no basic fault in the experimental regimen because of an omission.)

It is to be expected, in view of the established regimen for the medical supervision of these employees and the undesirability of interference therewith, that the examinations will be carried out in the usual manner, and that the collection of samples of blood and urine be obtained by the responsible physicians in conjunction with these examinations. Certain modifications of the regular regimen are suggested, however, as follows:-

(a) It is recommended that these examinations be carried out at quarterly intervals, beginning as soon as may be convenient after the operations concerned with TML have been initiated. The clinical data, as well as the analytical results on the samples, will then be available in sufficient volume for satisfactory comparison, on the time base of one year. (Containers for the collection of samples of urine and blood together with instructions for the same, will be supplied to the respective physicians, and these samples will be returned to The Kettering Laboratory for analysis at quarterly intervals.)

(b) It is desirable, if feasible, that the examination records (record forms) be the same as those employed in making the examinations, later to be described, at other sites. This arrangement and the provision of a copy of each record for The Kettering Laboratory will facilitate the extraction

of the clinical data for study and comparison. Record blanks for this purpose will be supplied by The Kettering Laboratory to the examiners. The examinations should be made and recorded in as uniform a manner as possible by the several physicians, and some advice along these lines will be sent out from The Kettering Laboratory with the record forms.

Despite the somewhat formalized procedures indicated in this relationship for the purposes of a systematic investigation, it is not desired or intended that the physicians should be limited in the performance of their function to the investigative role. Our intention is that of ascertaining the facts, through these expert eyes and ears, concerning the extent of the hazard of lead absorption associated with the handling of concentrated antiknock compounds under the present conditions in the mixing plants. Under certain circumstances this hazard might be highly significant. Errors or accidents in blending, or faults in the equipment leading to the escape of liquid or vaporized TML, might create hazardous conditions, and the seriousness of these, if they should occur, will be matters of importance. Physicians are urged, therefore, to be on the alert, without harboring anxiety or communicating it to the personnel under their supervision. Any untoward developments among the workmen, whether in the nature of illnesses or of undue concern for their safety, should be reported to Dr. Curtis and passed on to The Kettering Laboratory in appropriate manner according to his judgment, either as pertinent information, or as incidents or situations which require further investigation.

The analytical survey of the atmosphere in association with the installations and the mixing operations will be carried out by methods selected by Mr. Cholak and by personnel with whom he is able to make satisfactory arrangements (by local personnel so far as possible so that

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these observations can be made as conveniently and inexpensively as possible). Air analyses will be made at each site in sufficient numbers and with sufficient frequency to provide data representative of the variables of temperatures, air movement, and operating conditions.

(3) At sites in refineries (or bulk terminals) at which the vapors of gasoline and tetramethyl lead are most likely to be discharged into the atmosphere in the course of commercial operations, loading racks, barrel filling operations, or others.

Here too, the persons involved will be employees of Standard Oil Company of California, and present information indicates that the loaders of tank cars and trucks at the Richmond and Bakersfield Refineries will number about 30 persons. The corresponding personnel at the El Segundo Refinery appear not to be subjected to exposure of this type because of the nature of the physical facilities, and, therefore, they are not being included in this part of the survey according to present plans. Whether other refinery employees of comparable type are available elsewhere is not certain (to me), but the group indicated above would be adequate if it is representative of the most severe exposure of this type that is likely to be encountered.

There are said to be 10 persons in Seattle and Portland combined, whose work involves the filling of drums with gasoline. Whether or not these men should be included in the survey will depend upon the severity and constancy of their occupational exposure to vaporized gasoline. This occupation might turn out to be highly significant as a source of exposure, but the latter may be too slight to merit consideration. The distance between these two sites and the others under consideration will provide an unreasonably great obstacle to their inclusion (considering the small number of persons

involved) unless they provide occupational conditions of fairly crucial importance.

These employees of Standard Oil, in whatever number and at whatever sites may be settled upon, will be under the medical supervision of the Company's medical staff and, will be dealt with, presumably, with respect to the examinations and the sampling and analysis of urine and blood, in the same manner as the personnel of the mixing plants at the refineries, and on the same schedule, with reference to the intervals between examinations and analyses. The numbers of clinical and analytical observations which will result from adherence to this schedule will provide sufficient data for comparison and statistical analysis.

A program of air analyses sufficient to portray the environmental conditions - the nature and extent of the exposure of the workmen to vaporized tetramethyl lead - will be developed by Mr. Cholak in collaboration with the available technical personnel of the companies concerned.

(4) At service stations for dispensing gasoline to motor vehicles.

It is necessary to include in the survey a series of service stations that will be representative in a number of respects and satisfactory in certain others.

(a) First, the majority of these employees (attendants) must remain in employment during the entire period of the survey. The selection of sites and persons to be included must be based first on this consideration.

(b) Second, the location and facilities of these service stations must be such as to ensure a relatively extensive patronage, and a high demand for high octane gasoline.

(c) Third, the number of suitable persons under investigation in each of two conveniently situated and satisfactory cities - San Francisco

probably, and Los Angeles, certainly - from the aspect of climatic conditions, must be of the order of thirty to forty, for purposes of comparison.

These stations and persons (in all probability, all of the persons at each station will have to be included in the survey, regardless of their suitability and, therefore, the total number involved may be appreciably greater than the number of suitable persons) are to be selected after a preliminary review of their suitability in respect to factors (a), (b), and (c) above. They will be examined by members of the medical staff of The Kettering Laboratory, and samples of urine and blood (and, perhaps certain other specimens for laboratory examination) will be obtained during an initial campaign soon after the introduction of TML, and in a second survey carried out nine months (slightly more or less, according to the convenience of all persons concerned) after the completion of the first. (These men are not subjected to any significant hazard, and the nature of their work as filling station attendants is so well defined as to exclude the likelihood of any unusual or unanticipated opportunities for exposure to lead. Accordingly, no useful purpose would be served, it seems, by the repetition of these observations at quarterly intervals.)

A program of atmospheric sampling and analysis will be scheduled by Mr. Cholak, and implemented in as convenient and inexpensive a manner as possible. It should include determinations of the extent of the contamination of the air with particulate lead, lead alkyls and total lead at intervals throughout the year. This may be, and in our view should be, combined with a comparable (not elaborate but revealing) survey of the levels of concentration of the same forms of lead in the air of Los Angeles, in particular, and in San Francisco as well, but perhaps in

areas adjacent to, but not unduly influenced by, the operations of the selected service stations. (Determinations of the carbon monoxide content of the air should be made in concert with the determinations of lead at the filling stations and at the other sites adjacent to them.) Such observations will meet not only the suggestion of the Public Health Service, in relation to a "major metropolitan center," but also will supply current data of a generally useful type in relation to the over-all problem of contamination of the urban atmosphere with lead. In view of the convenience and economy of obtaining these data along with the others, it would be somewhat less than prudent, in our opinion, to fail to take advantage of this opportunity. The fact that certain other observations of this type will be made by other persons or groups on behalf of the State Health Department of California, or, perhaps for the United States Public Health Service, only makes it the more essential that comparable data should be obtained by ourselves. Our collaboration with official investigators is advisable for several reasons, but, primarily, for the purpose of maintaining for ourselves and for the industries concerned, a direct and satisfactory knowledge of the facts at all times.

(5) In a garage.

A repetition and extension of the preliminary experimental program carried out and reported recently (Report of The Kettering Laboratory dated November 10, 1959) is highly desirable, in that the occupational absorption of lead by persons who are employed regularly in certain repair and maintenance garages has been shown to be detectable, in contrast to that of filling station attendants and refinery handlers of gasoline containing tetraethyl lead. Any increase in the absorption of lead which might derive from the substitution of TML for TEL, while having been found to be too small

for detection in observations made over the period of six weeks (see Report referred to above) might possibly be sufficient for detection within the period of eight months, or not at all. This possibility seems slight but it must be explored. It is to be hoped, therefore, that a suitable parking and service garage can be found, preferably in Los Angeles. In order to serve its intended purpose, such a garage would have to fulfill the following specifications:

(a) It should have good patronage, especially by purchasers of gasoline. A parking garage merely filled to near capacity with parked cars throughout the greater part of the day, with a minimum of short term parking (coming and going), and with only a modest turnover of gasoline, would be entirely unsatisfactory for our purposes. The maximum of fueling and of cars coming and going for that purpose would provide the principal desirable feature, since the concern here is not primarily, or even importantly, with exposure to particulate lead in the exhaust gas, but to unburned gasoline and lead vapors, derived in part from operating cars (as the result of "blowby" etc.), but to a greater extent from the handling (and spillage) of gasoline from fuel pumps to automobile fuel tanks (displacing vapor therefrom).

(b) A large proportion of the gasoline dispensed to the patrons should be of the high octane variety containing TML in a concentration near the upper permissible limit. Otherwise the observations will have little or no relationship to TML and can be counted on in advance to be entirely negative.

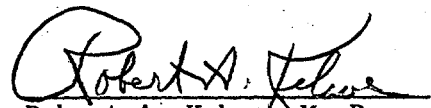
(c) The ventilation of the garage should be on the low rather than the high side in its speed and thoroughness in effecting changes of air within the garage.

(d) The personnel of the garage must be of such stability in employment as to justify the reasonable assurance of their continuance in employment during the course of the experimental observation. If there is a high turnover among the employees, the results of the observation will be inconclusive and the entire effort will be fruitless.

(e) There must be thirty to forty suitable employees in a single garage of the type indicated or in several suitable garages not too distant from the site at which the medical examinations can be carried out.

If no garage that meets the foregoing specification is available in Los Angeles, but is available in San Francisco, the observations may be made in the latter city. If no such garage is available in either city or in some other suitable community within the area of distribution of the product, no useful purpose will be served by carrying out this part of the investigation at this time, since, in any case, corresponding work will have to be done later when a satisfactory site shall have been found.

An appropriate experimental regimen, comparable in principle and in scope to that described above for application at other sites, will have to be designed to fit the conditions that exist within a garage that is believed to be suitable and at the same time amenable to investigation.


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