

COMMITTEE ON LEAD TETRA-ETHYL.

Board of Works, S.W.I.

Monday, 11th June, 1928.

Minutes of Evidence.

taken before

THE COMMITTEE APPOINTED BY THE MINISTER OF HEALTH.

"To enquire into the possible dangers to health resulting from the use of motor spirit containing lead tetra ethyl or similar lead-containing compounds and to report what precautions, if any, are desirable for the protection of the public or of individuals in connection with the use or handling of such motor spirit".

Present:-

Sir Frederick Willis, K.B.E., C.B., (Chairman).
Dr J. C. Bridge, F.R.C.S.,
Sir George Buchanan, C.B., M.D.,
Professor A. C. Chapman, F.R.S.,
Professor W. E. Dixon, M.D., F.R.S.,
Dr C. H. Lander, D.Sc.,
Sir Charles J. Martin, C.M.G., D.Sc., F.R.S., F.R.C.P.,
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(Transcript from the Shorthand Notes of GEORGE MOORE & Co.,
38, Parliament Street, Westminster, S.W.1. Tel: Victoria 1875.)

Dr J. P. LEAKE called and examined.

CHAIRMAN: Before you begin, Dr Leake, I would like, on behalf of the Committee, to express our thanks to you and to Surgeon General Cumming of the American Government, for your great kindness in coming over to this country and telling us about your American experience and what has been done in the United States. We are very greatly indebted to you for it.

Q I understand that it was about 1923 when it was proposed first to use lead tetra ethyl in petrol for the purpose of getting rid of knock in the engine? --- The ^{technical} ~~mechanical~~ (?) history I am not entirely familiar with, but it began to be used at that time. I think some of the work on it was published in ^{technical} ~~mechanical~~ journals possibly earlier than that. So that in the technical fields discussion had been going on possibly previously to that.

Q At the outset what was the feeling in regard to the use of this material? --- There were great fears on the part of chemists and ^{toxicologists} ~~pathologists~~ and those engaged in public health as to the ^{possible} dangers from such a compound being used so freely in petrol ~~in engines~~.

Q You felt on general grounds that there was some justification for the fears people had in regard to this material? --- There seemed to be ample justification, and the fact that lead is an accumulative poison and that this substance itself is particularly poisonous.

Q Then I think in 1924 something serious occurred? --- There was rather a sudden number of fatal poisonings which

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Q Then I think in 1924 something serious occurred? --- There was rather a sudden number of fatal poisonings which occurred in New Jersey, where tetra ethyl lead was being made or handled, and that caused a great deal of public alarm. Before that the alarm had been amongst those who ^{particularly concerned with Public Health Work} were ~~more or less~~ particularly concerned in scientific ~~chemistry and so forth~~ work, ~~chemistry and so forth~~; but the public were alarmed

Dr Leake.

and a great deal was ^{said} ~~spread~~ in the papers in regard to this subject.

Q Then ^I think the Surgeon General of the United States Public Health Service called a Conference? --- He did, on as early a date as he could, to get before him at that Conference some of the results of the work which had been instituted ^{prior to that} ~~by those interested~~. It was in May 1925 that he called that Conference.

Q That Conference was attended by whom --- I do not mean the names, but the sort of interests? --- In general those were invited who were interested at all: public health workers, chemists, technical men, and those who had expressed particularly to the Surgeon General their fears in this matter.

Q As the outcome of that Conference, I think it was decided that the Government, under the Public Health Department in the United States should appoint a Committee? --- The Conference adjourned after a good deal of discussion, having passed just before the adjournment a resolution that the matter be referred to the Surgeon General: that a Committee be appointed by him to report to him about the first of the next year -- January 1926 -- as to the dangers in the public use of the product.

Q I notice that the Committee were asked to answer really much the same questions as this Committee has been asked to answer. In America they were asked to make a statement as to the health hazard involved in the retail distribution and general use of tetra ethyl lead gasoline as an ^{asked}

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Q I notice that the Committee were asked to answer really much the same questions as this Committee has been asked to answer. In America they were asked to make a statement as to the health hazard involved in the retail distribution and general use of tetra ethyl lead gasoline as an automobile fuel. The Committee was not ^{asked} ~~appointed~~ to go into the manufacture of tetra ethyl lead itself or the bleanding of it, but merely to investigate the question as to whether there was any public danger by the use of ^{in the use of petrol} ~~the use of~~ ^{containing this material in the amounts that you found} ~~tetra ethyl lead in this material in the amounts you found?~~ --- It was a public health question.

Dr Leake.

Q The members of this Committee were, I suppose, among your most eminent scientific men in America? --- They were generally regarded as being as able a Committee as could be appointed for such a purpose, and it was composed of first Dr Chesley, who is Executive Health Officer, Minnesota State Board of Health. Those State Health Officers, of course, were officials directly responsible to the Federal Government. According to our constitution the Federal Government has no immediate responsibility in these matters, except that of advice, it being left to the different States. Then Dr Edsall, who was Professor of Clinical Medicine at the University of Pennsylvania and Harvard University, being then Dean of the Medical School and School of Public Health at Harvard. He had expressed serious concern about the matter. Then Professor Howell, who has written a text book which, I suppose, is used more than any other in America on physiology. He is not purely a medical man, he is professor of Physiology at the University of Michigan, and he was also at Harvard and for a long time was Professor of Physiology at Johns Hopkins Medical School, and he is Professor of Physiology at the School of Hygiene and Public Health, Johns Hopkins University, and is now at that school. Then Professor Reid Hunt, who was formerly Professor of Pharmacology at the Hygienic Laboratory, United States Public Health Service, and was at the time the Committee was appointed, Professor of Pharmacology at Harvard University Medical School. Then Professor Leather, Professor of Preventive Medicine, Vanderbilt University. He in a way also represented the State authorities, inasmuch

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organic chemists in the country. Then Dr Winslow, Professor of Public Health at the Medical School, Yale University. ~~He has been Professor of Technology~~ and he was President of the American Public Health Association at that time. Those were the Committee. Professor Howell was chosen as Chairman.

Q That Committee decided to make certain experimental observations themselves? --- They did.

Q And you were placed in charge of the investigations? --- Yes

Q You made an interim report at the end of the year and on January 19th the Committee drafted and signed their final report? --- They did.

Q Will you tell us what their investigations covered?

--- The investigation was undertaken to discover what health hazard, if any, is involved in the retail distribution and use of tetra ethyl lead gasoline as an automobile fuel. It was generally felt that the previous investigations on animals could not give a satisfactory and definite answer to this question, therefore human subjects were studied, who had been exposed to the actual use and in the distribution of this product for some period. I may say that during the continuation of this investigation the Ethyl Gasoline Corporation, who control the distribution of the product, withdrew it from public sale. It was still, however, in use in an area in South Western Ohio, where it had been first used; that was fortunate for our study, because subjects could be chosen from that area who had been exposed for the longest time possible, and control groups were also

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Dr Leake.

The second group B. consisted of 77 car users who were similar to group A. except that their exposure was to ethyl gasoline: group C. was another control group of 21 garageworkers and gasoline handlers who were exposed to gasoline other than ethyl gasoline. Then group D. was a test group on the other hand, comprising 57 garage workers and gasoline handlers, similar to group C, except that the exposure was to ethyl gasoline. We had, therefore, two control groups not exposed to ethyl gasoline, one representing more or less the general automobile ^{Public & Drivers} and ~~garage workers~~ ^{handlers & garage workers} drivers, and one representing ~~the ethyl gasoline exposures.~~ ^{Both exposed to Ethyl Gasoline} Then there ~~were~~ ^{And the} two test groups, ~~one representing the general automobile and garage workers~~ ^{one representing the general Public and Automobile Drivers & the other with more intense exposure} and the other the more intensely exposed in ethyl gasoline using establishments. We had a fifth group: that consisted of men exposed definitely to a lead hazard. That was to determine whether our methods of enquiry were adequate to show whether lead poisoning had occurred in people who were still able to go about their usual employment.

Q What class of work ^{car} would that last group comprise?

--- They were in storage factories, as we call them.

Q Storage works? --- Yes.

Q Nothing to do with cars? --- No.

Q As to your plan of work, what did that include? --- I may say that the results are published in the Public Health Bulletin 163, published by the Treasury Department of the United States Health Service, to which I am referring now -- published in June 1926. The plan of work included

garageworkers and gasoline handlers who were exposed to gasoline other than ethyl gasoline. Then group D. was a test group on the other hand, comprising 57 garage workers and gasoline handlers, similar to group C, except that the exposure was to ethyl gasoline. We had, therefore, two control groups not exposed to ethyl gasoline, one representing more or less the general automobile ^{Public & Drivers} and ~~garage workers~~ ^{handlers, garage workers} drivers, and one representing the ~~ethyl gasoline exposures~~ ^{both exposed to Ethyl Gasoline}. Then there ~~were~~ ^{And the} two test groups, ~~one representing the general automobile and automobile drivers and the other the more intensely exposed in ethyl gasoline using establishments.~~ ^{one representing the general Public and Automobile drivers & the other with more intense exposure to Ethyl Gasoline in garages and garages for both groups}. We had a fifth group: that consisted of men exposed definitely to a lead hazard. That was to determine whether our methods of enquiry were adequate to show whether lead poisoning had occurred in people who were still able to go about their usual employment.

- Q What class of work ^{car} would that last group comprise?
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Dr Leake.

An estimation of the red cell count, a count for stippled cells and an examination of a specimen of the feces for lead. In planning the investigation we laid special emphasis on these methods which would possibly yield we thought more definite quantitative results, regarding slight variations from the normal: at the same time they would be free from subjective ~~errors~~ ~~records~~ -- what might be called the personal equation. First there was the determination of the amount of lead in the feces, which would show lead exposure or lead absorption.

The second was a quantitative ~~examination~~:

~~the~~ examination of red blood cells for

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of the wrist.

Q It has been suggested to us that the ^{men} ~~men~~ using of this ethyl gasoline was so carefully warned by you that they exercised much more than ordinary care; that is to say they were really not typical of an ordinary garage worker who not know an experiment was being made, and that therefore they did not expose themselves to the real risk which the average garage worker would do if this material were in constant use everywhere. Did you find that these men were very specially careful? --- That might be supposed by an outsider, but the fact is that that is not true at all because in ~~the~~ the first place this was the district where the material was first used, and as is quite obvious from the history of the material, it was used carelessly at first, the men taking no precautions. They were in the habit of spilling it over themselves, and they placed it in their hands, and one of the garages was extremely dirty and ill-ventilated, and the man took very poor care of themselves or their clothes, or their skin: there were no precautions taken, and that was quite representative of as poor sanitary methods as you would ordinarily get.

Q You really think that that objection was invalid?
--- It is invalid in this case.

Q There is another point I want to ask you about.

You examined the excreta for lead; did you do that because you considered the lead in the excreta afforded a really satisfactory index to the lead in the human person? --- We could not judge it in an individual,
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You examined the excreta for lead; did you do that because you considered the lead in the excreta afforded a really satisfactory index to the lead in the human person? --- We could not judge it in an individual, ^{how much} as to ~~whether~~ lead was stored, by the lead in his excreta, but in a large group who were continually under the exposure, which we were investigating - the exposure to this ethyl gasoline - if they were storing lead,

that group as a whole would show more lead in their excreta than the controls, who were presumably not storing lead - at least, not storing any more than the ordinary people in such occupations.

Q I was wondering, if it were possible for the lead excreta to remain pretty constant whilst in some other parts of the body they were getting a steadily accumulating amount of lead? --- That might well be in an individual; but taking a group, I think we could reason presumably that such storage did not take place except as indicated by the excreta.

Q Taking the whole group of men, you say that is a very fair measure of lead if stored anywhere? --- Yes, a fair measure.

Q Then I believe you took careful precautions to guard against individual bias on the part of the examiners? --- That was a thing as to which we perhaps endeavoured more than any other to make our work different. The actual workers who did the quantitative examinations, whether on the subjects of the blood or the excreta, could not tell whether they were examining men who had been exposed to the ethyl gasoline or whether they were men who had not been exposed. The control groups and the exposed groups were mixed up and rather an elaborate system of numbering specimens was used; so that it could not be determined at all. We felt that that was necessary in order to guard against subjective errors, and it was co-operated in by all the workers. They realised the

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Q This is quite apart from your evidence, but I remember some years ago being on a committee that was enquiring into the danger connected with bacteria getting into water

supplies, and they sent a sample of water taken quite near a sewage outfall to an independent bacteriologist without telling him where it came from, and another sample which was very pure water, and he found more coli in the very pure water than he found in the sewage outfall water; and he very much objected afterwards that he was not told where those samples came from.

Q What were the results of your examinations? --- So far as the careful clinical examinations were concerned, there was no lead poisoning among the automobile drivers using ethyl gasoline. The fifth group, who were exposed to a definite lead hazard - all of whom were supposed to be entirely free from symptoms which would keep them from their work - did show by our tests in some cases definite lead poisoning.

Q That is the men working in connection with the accumulators? --- Yes. Our clinical methods, in other words, we found to be close enough to show up in those men, although for the purpose of their employment they were normal men. In regard to the lead exposure, the lead was indicated in the feces, and the lead absorption was indicated by the stippled cells and the red cell counts. The garage workers and gasoline handlers, that is our group C & D, showed more lead than the automobile drivers representing the general public in America. In the case of the garage workers and gasoline handlers who were exposed to ethyl gasoline there was a slightly greater amount of lead shown than in those who were not exposed to the ethyl gasoline; but these slight increases were of an entirely different order of magnitude from the comparatively very great amounts of lead shown by group E. I may say that

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Dr Leake

So that a positive result there was not what would be called a positive result in ordinary analyses, and in the same way with stippling. We found stippling in presumably normal persons, whereas ordinarily I believe stippling is indicated as something to do with lead, and it was so felt by us - that is a definite lead exposure - to be of some import ordinarily. But we found some stippling in all groups; ^{was actual} that the mere fact of there being lead in all groups in ^{the} ~~fact of there being stippling in all groups, was not what~~ ~~stippling found by ordinary means of examination~~ ~~would be called lead in the faces or stippling in the blood,~~ ~~by ordinary methods of examination.~~

- Q Did you make any other studies? --- We also collected samples of the air by the impinger method, and of the settled ~~xxx~~ dust in these garages; and we found lead in garages even where no ~~the~~ ethyl gasoline was used: which accorded of course with our finding in the individuals who were working there. Those amounts of lead were of an entirely different order of magnitude than those found in the actual places where there was a definite lead exposure.
- Q That is the accumulator works? --- Yes. Then we did another thing which possibly does not give to the individual reading the results or hearing of them as vivid an impression as is obtained by the actual investigator. It was felt that it was very possibly that cases of injury could occur in those garages where ethyl gasoline was used, of possibly minor or possibly more severe intensity; and that the people who had suffered such slight or distinct injury would of their own accord get out of those garages and out of that employment; and that by examining those who were present in those
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Q Quite. --- So we endeavoured by every means at our command to

Dr Leake

seek out any who might have been exposed and suffered injury and gone to other cities or sought other employment; and we secured very excellent co-operation from the people from whom we enquired. We were quite able to assure them to their satisfaction that our enquiry was quite disinterested, and that their employers would not hear of what they told us. They were very ready to tell us of instances that they had heard either indirectly or directly of the supposed injury caused by this material; and those instances were in all cases investigated, no matter in what part of the country they were, and in no case whatever was there any foundation for the supposition that this ethyl gasoline was to blame. The details of some of them are given in this report. It was very convincing to our minds, inasmuch as the men were very frank to tell us of such supposed cases.

- Q. Do you think that any definite injury from ethyl petrol would be likely to get reported to you if it occurred, or would you be likely to get to know of it? --- Much more so than of other injuries or diseases, on account of the great publicity that was given to the subject in the newspapers and generally. Notices of course we placed on all pumps; The gasoline was coloured differently from other gasoline; and there was discussion generally about it; and the Health Officers themselves were on the lookout. They had discussed the thing

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Jul 28/44
L1.

Dr Leake.

Q Perhaps you might tell us what were the conclusions of the Committee as the result of their investigation?

--- I think I should read them in their own words. "The Committee concluded that drivers of cars using ethyl gasoline as a fuel and in which the concentration of tetra-ethyl lead was not greater than one part to 13 hundred parts by volume of gasoline showed no definite signs of lead absorption after exposures approximating two years. (2) Employees of garages engaged in the handling and repairing of automobiles and employees of automobile service stations may show evidence of lead absorption and storage, as indicated by the lead content of the feces, and the appearance of stippled cells in the blood. In garages and stations in which ethyl gasoline was used the amount of apparent absorption and storage was somewhat increased, but the effect was slight in comparison with that shown by workers in other industries where there was a severe lead hazard". That is our Group E. "And for the periods of exposures studied was not sufficient to produce detectable symptoms of lead poisoning. (3) In the regions in which ethyl gasoline has been used to the greatest extent as a motor fuel for a period of between two and three years no definite cases have been discovered of recognizable lead poisoning or ~~to~~ other disease resulting from the use of ethyl gasoline". Then they summarise the matter in this sentence. "In view of these conclusions your committee begs to report that in their opinion

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say: "In conclusion we beg to say that we are conscious of the fact that the conclusions to which we have come in this report, although based upon most careful and conscientious investigations, are subject to the criticism that they have been derived from the study of a relatively small number of individuals who were exposed to the effects of ethyl gasoline for a period of time comparatively brief when we consider the possibilities in connection with lead poisoning. A more extensive study was not possible on account of the limited time. It remains possible that, if the use of leaded gasolines becomes widespread, conditions may arise very different from those studied by us which would render its use more of a hazard than would appear to be the case from this investigation. Longer experience may show that even slight storage of lead as was observed in these studies may lead eventually in susceptible individuals to recognisable lead poisoning or to chronic degenerative diseases of a less obvious character".

Q May one interpret that in this way: that your Committee consider that as the result of their investigation there was no evidence at all to show that there was danger to health? --- That is true.

Q But as scientific men they said: "We should like these observations to be continued for further years"? --- Precisely.

Q That is what it came to? --- Yes.

Q So far as your observations went, they did not indicate danger at all? --- None whatever.

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Q That is what it came to? --- Yes.

Q So far as your observations went, they did not indicate danger at all? --- None whatever.

Q I think further studies have been carried out? --- Groups of exposed persons at the same and similar places have been studied with controls by Officers of the Health Service and chemists from the University, at the instance of the

Dr. Leake.
It was not felt justifiable that Public Health Service should be expected to do an elaborate study in the way of a Public Health Service industry concerned.

- Q I think we have been told that you were in touch with those further studies that have been made? --- Yes.
- I saw their general plan. I watched some of the examinations that were being made, and I looked over ^{considered} and edited ~~considered~~ the report before it was made.
- Q Is it your definite opinion that these further examinations have been reliable? --- It is *my definite opinion.*
- Q I think I am right in saying that several men whose excreta ^{at least} has been examined now for four years show little or no more lead in the excreta today than they did four years ago, although they have been exposed to the same risk, if there is a risk, right through? --- Yes.
- Q That is generally the result of those further studies? --- That is generally the result; it shows no difference from the results that we published in this Bulletin.
- Q Do they support, as far as they go, the evidence which the Government Committee got together? --- They do.
- Q So that so far there is nothing to indicate that if you carry on this work for 20 years you will get a greater amount of lead in the excreta? --- There is nothing whatever.
- Q Nothing to show that? --- No.
- Q For four years you did not get any more in? --- That is right.
- Q Was there any other particular independent investigation of possible harmful effects from ethyl gasoline made by the United States Public Health Service? --- By means of private enquiry and by the use of the Press Clipping Bureau

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Q Was there any other particular independent investigation of possible harmful effects from ethyl gasoline made by the United States Public Health Service? --- By means of private enquiry and by the use of the Press Clipping Bureau we tried to ascertain whether anyone had heard of any injury from the use of this substance, and we found no case. We also asked the State Health Officers to ascertain if any had occurred -- so far as they could -- and we have got the replies to the Surgeon General, who was here the other

day, that up to that time they had found none.

Q Your results have been entirely negative so far?

--- Entirely negative.

Q Do you think if there had been ill effects they might have been easily overlooked or remained unreported? --- That is the case with any disease ~~or~~ condition; but as I mentioned before, this has been the subject of particular public agitation and concern on the part of the Health authorities, and it has been in the Medical Journals as well; so I believe it would be much less likely to be overlooked than in the case of other injuries.

Q Then I believe you suggested certain regulations in the United States? --- In conformity with the suggestion ~~and~~ of the Committee regulations were drawn up and they were printed in this same Bulletin. There were four sets of regulations: first for the manufacture of tetra-ethyl lead and the blending of the ethyl lead to make ethyl fluid. Secondly for mixing the ethyl fluid with the gasoline to make ethyl gasoline: thirdly for the distribution of ethyl gasoline, and fourthly for the automobile garages, repair shops, service stations and filling stations.

Q If those regulations that you suggested were absolutely carefully observed everywhere, would you have a more careful state of things than you had when you were making your experiments? --- Oh very much more.

16 (top)
Q Notwithstanding that fact you feel it desirable to suggest these regulations? --- Yes. It was obvious that the first part of these regulations, or something analogous

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Q If those regulations that you suggested were absolutely carefully observed everywhere, would you have a more careful state of things than you had when you were making your experiments? --- Oh very much more.

Q Notwithstanding that fact you feel it desirable to suggest these regulations? --- Yes. It was obvious that the first part of these regulations, or something analogous to them, were needed on account of the deaths that had occurred in connection with the pure substance.

Q That was the manufacture? --- Yes.

Q But I am thinking of the garages where they use ~~xxx~~ this

15.

Dr Leake.

commercial mixture? --- As a matter of fact the Surgeon General, apart from the Committee, would not countenance the use of this material if its safety simply depended on the carrying out by so many individuals of such regulations in detail as are set down here for automobile garages, repair shops, service stations and filling stations. Of course these regulations are proposed regulations: it is not within the authority of the Federal Government of the United States to make such regulations for individual industries, but they are proposed for adoption by the various States. So far I know only one State has adopted them; and as far as I know it was only the first three sets of regulations that I have just enumerated. However ~~for~~ the Corporation which is engaged in the distribution of this product, agreed with the Surgeon General that they would be carried out, and as far as I know they have been entirely. Those first three sets of regulations, on the manufacture, mixing and distribution. -- As far as the last set is concerned particularly that is aimed -- as I think you may see -- towards what was brought out as evident from our investigation of lead gasoline -- that is: that the great danger in automobile garages is carbon monoxide, and it was done not with the view that these regulations would necessarily be adopted. We realised that no machinery existed for their active enforcement, but as a warning and as a criterion for the carrying out of proper precautions in garages.

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- Q Should I be right in saying that you think those precautions ought to be observed in garages, whether they are using ethyl gasoline or whether they are using ordinary petrol? --- That is exactly so. These were for all garages, whether they were using ethyl gasoline or ordinary gasoline.

Dr Leake.

Q In other words you consider no greater precautions are necessary if they are using ethyl gasoline than with ordinary petrol? --- Not necessary, but advisable. So far as we have determined we have not found any injury from the use of this, but we do deprecate any more lead in the human economy than is necessary.

Q Quite. Anything you can do to lessen it you would like to do? --- So much the better: but we have not found that it is necessary.

Q The Surgeon General's attitude I understood was this: that if the public safety could only be secured by the strict observance of these regulations in the garages, than the material ought not to be used? --- Then the material ought not to be used.

Q Because you realise that you cannot secure close observance of regulations such as those, in every garage? --- Precisely.

Q It would be just the same in this country, of course. Does it seem likely that less obvious forms of poisoning than were found by the Surgeon General's Committee had occurred? --- It would seem likely that if there were less obvious forms of poisoning in any considerable number the more obvious forms would ^{occur} also in a few, inasmuch as the exposure and the susceptibility of different individuals vary so greatly, and inasmuch as we have had no instances of the obvious and typical forms of poisoning, that I can discover, we have no reason to suppose that the less obvious forms of poisoning are going on.

Q Quite. Have you got anything to say as to the possible

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Q Quite. Have you got anything to say as to the possible poisoning by tetra ethyl lead in gasoline being looked upon as a different thing from lead poisoning? --- Professor Dixon would probably be better qualified to speak of that than myself. The cases of acute tetra ethyl lead poisoning from the pure substance have not been essentially different

Dr Leake.

from the cases of lead encephalopathy that we do encounter: restlessness, loss of sleep, lower blood pressure, delirium, dreams, all occurred. It is possible of course that such a thing may be -- and there are other forms of poisoning, of course. We have on record, for example, iron ^{Carbonate} poisoning. But it is possible that any metal fixed in the central nervous system may give rise to similar symptoms. We have no grounds for believing that there is a slow chronic form of cerebral lead poisoning as distinct from ordinary lead poisoning. It is the accumulated action of lead that we are afraid of in this whole matter: that is the only thing -- fear for the general public.

Q Do you consider there is a great danger to the general public -- you do not I suppose -- from the use of this material? --- We do not -- absolutely.

Q The danger to the garage workers who are exposed to this material is much greater and if they do not suffer you would argue -----? --- That the public is entirely safe.

Q Have you anything to say as to whether restrictive action should be continued or not, in regard to the distribution of this material? --- We have found no grounds for condemnation. We are told that there is the economic value in the use of the product. We do hope that other means may be found for reducing the knocking qualities of gasoline other than by the use of lead. There are other substances, such as for example, iron carbonate and benzine -- we do not feel that they are any safer, at any rate. We know the action of iron carbonate on white blood corpuscles,

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Dr Leake.

- Q Would you go as far as to say there is less reason, by reason of the further observations that have been made? --- Yes, I think that would be safe: that the further observations have confirmed us and therefore made the possibility of danger less likely. The comparison might possibly be made with such a thing as white bread. Some of us might prefer whole wheat bread for various reasons, but that would not lead us to decree that white bread should be barred from the market. The comparison is not entirely apt.
- Q Would you say it was the general opinion among engineers in America -- perhaps it is not a fair question to ask and you can decline to answer it -- but is it the general opinion among engineers, as far as you can ascertain, that this material is of considerable value to mix with petrol for the purpose of preventing knock and improving the efficiency of engines? --- When this report was given by the Committee (this is simply hearsay) the President of the Society of Engineers rose in the meeting and said that was the most important decision that could possibly be made for automobile design.
- Q You mean by that that in his opinion it was of very real value? --- It was very valuable and very important.
- Q I suppose if in America you had been satisfied that it was of no real value would you have said: "In view of the ^{un}desirability of having fuel like this it had better not be used"? --- We would have no ground for doing that even -- on the basis of
- 20 (top)

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SIR GEORGE BUCHANAN: I think you have answered almost all the questions that I wanted to put. Just to have it clearly on our note: what exactly is your position in the United States Health Service? --- I am a surgeon and a regular Commissioned Officer of the United States Public Health Service, and I have been entrusted with this investigation.

Q You are a whole-time salaried officer of the United States Health Service? --- Entirely. That is my career.

Q You do not take private work? --- No.

Q Or get remuneration apart from your salary?

--- None whatever.

Q So far as there is any question of natural bias in an enquiry of this kind, your bias would be the bias of a Service that stood to be shot at if it failed to detect any danger?

--- Yes. I may say that the first time that this material came before me it was brought by a man in the Service who afterwards rendered very considerable aid in the investigation, and he felt that there was a real danger in the matter.

I myself felt at first that there might be a very considerable danger in the substance.

Q The whole enquiry originated, as I understand it, in reference to a possible danger to the citizens of the United States. There was no question till much later of any extension of the trade to other parts of the world?

--- No. It was wholly in the United States.

Q You were looking after your own citizens? --- That was the whole thing.

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Q On this point about the possibility of there being some unsuspected form of chronic poisoning attributable to the ethyl gasoline, having unusual symptoms -- nervous symptoms that have not been associated perhaps with lead poisoning at all: that, of course, has been suggested to us, and

there are one or two analogies -- as you know quite well -- in other histories of poisoning, where something has occurred and where the thing has been going on for some time and the actual origin has not been suspected. I think you told us that if that was occurring now you think you would probably get it brought to notice, partly in view of the publicity the thing has attained, and partly because you have ordered the Health Officers of the States to look after any kind of question of that kind; but would that really get you very far? ~~carbide~~ ^{carbide} or otherwise, had been occurring, which had not been associated with lead, but was really due to ethyl gasoline; how do you think it would be brought to notice. Do you think you would get the cases reported in the ordinary medical papers in the first instance? ---They would come to the attention of physicians in the first instance, and such cases would appear in medical papers, or very possibly be brought directly to the attention of Health Officers in one way or the other, by the physicians or by individuals. Not infrequently individuals report cases to the Health Officers.

- 22 (top)
- Q Should anything of that sort appear, would it come to you in Washington. Would you be almost certain to know of it -- any suggestion of any unusual illness that might be attributable to lead? --- Yes; the whole machinery would point right up there, so that ~~ix~~ any State Health Officer or any Medical officer as a matter of routine would send it to us.

and where the thing has been going on for some time and the actual origin has not been suspected. I think you told us that if that was occurring now you think you would probably get it brought to notice, partly in view of the publicity the thing has attained, and partly because you have ordered the Health Officers of the States to look after any kind of question of that kind; but would that really get you very far? Supposing that some nervous affection, ~~central~~ ^{cerebral} or otherwise, had been occurring, which had not been associated with lead, but was really due to ethyl gasoline; how do you think it would be brought to notice. Do you think you would get the cases reported in the ordinary medical papers in the first instance? --- They would come to the attention of physicians in the first instance, and such cases would appear in medical papers, or very possibly be brought directly to the attention of Health Officers in one way or the other, by the physicians or by individuals. Not infrequently individuals report cases to the Health Officers.

- Q Should anything of that sort appear, would it come to you in Washington. Would you be almost certain to know of it -- any suggestion of any unusual illness that might be attributable to lead? --- Yes; the whole machinery would point right up there, so that ~~if~~ any State Health Officer or any Medical officer as a matter of routine would send it to us.
- Q Would you still regard it as part of the business of the Service to make enquiries of any individual cases through your own officers? --- Yes.
- Q Supposing later on any evidence occurred which did give rise to a belief contrary to what you have at present on the

evidence before you, that a danger was arising from this substance, could we in England be quite safe in assuming that official publicity, through any enquiry into that matter, would be given? --- I am sure it would.

- Q For example take your own Public Health Bulletin, which generally contains the account of any new enquiries into disease conditions, done by your Service: might we assume we would at once find the result of any enquiry there; or ~~some~~ some other means by which we are habitually informed of the kind of disease and its prevention? --- I am sure you would rely not only on that, but probably it would be prompter than that, through the Ministry of Health.

- Q There was a question the Chairman was asking you about the original criticism of the experiments that were made between the garage workers and the controls; it was said that there were two objections: one was that the controls were not perhaps particularly healthy people, and the other was that the garage workers had been taken from very excellent sources. I understood that your answer was that there is further evidence in the same direction by what has happened since. Have not you had afterwards a much more extensive series of experiments in which the controls were, for instance, medical students and people of that sort -- in good condition? --- There have been. Those were the enquiries carried out by the personnel of the University ^{at} Cincinnati. The objection, I think, that was made in the first place was made to some work that was done previous to this, more or less along the same lines, where the controls were not quite comparable.

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Q But you are satisfied now? --- Yes, absolutely.

CHAIRMAN: Your own controls were from garages and they were men of a similar position in life? --- They were; and the

garages were at least as good, in fact they were better than the best garages where the ethyl gasoline was used.

SIR GEORGE BUCHANAN: Have you any opinion as to the desirability or necessity of this kind of experimental work being continued longer?

but
--- Just along the same line that you have before you:

that is four sets of comparisons: the use of ethyl gasoline in the United States has spread very widely.

I do not believe it will be possible in the future to take clear cut control groups and test groups, on account of the wide diffusion of the product:

I mean that there is no garage or no group of garage workers for the future in any considerable number -- as perhaps you noticed in the last report.

The numbers of those who have continued without the substance ^{through} the four or five years are dwindling, on account of the natural labour turnover. I do not think it will be possible to get groups which will be comparable and which will be purely control groups, and a test as regards the exposure to ethyl gasoline. I think that answers your question.

Q You mean the experiments will not continue because the conditions will not continue?

--- Not exactly along those lines.

CHAIRMAN: You mean you cannot get garages in the

better than the best garages where the ethyl gasoline was used.

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CHAIRMAN: You mean you cannot get garages in the future where they are not using ethyl gasoline?

--- Where we cannot be sure of it.

Q You could go on observing the men where they are using the ethyl gasoline?

--- Quite.

SIR GEORGE BUCHANAN: In regard to the regulations for the distribution of ethyl gasoline, I have here the regulations that are suggested: that the containers sold to the general public should be labelled, that it should be used for motor fuel only and not for cleaning or any other purpose. Have any cases been brought to your notice that people have used this for cleaning and other purposes? -

--- They indeed have. One of the professors in Dr Howell's school, and a colleague of mine, found that his servant had used it for cleaning the floor, and splashed it over everything, his hands and everything else.

Q Obviously it would be very desirable to prevent that use. What I was interested in was whether you had come across instances of it being accidentally or carelessly used in that way and yet no particular harm had been done?

--- That is true.

Q Or any harm?

--- We have found no harm. In those investigations in the garages it was splashed round on hands and faces rather indiscriminately. The dye of course tends to keep it from being used quite as much as other gasoline.

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the distribution of ethyl gasoline, I have here the regulations that are suggested: that the containers sold to the general public should be labelled, that it should be used for motor fuel only and not for cleaning or any other purpose. Have any cases been brought to your notice that people have used this for cleaning and other purposes? -

--- They indeed have. One of the professors in Dr Howell's school, and a colleague of mine, found that his servant had used it for cleaning the floor, and splashed it over everything, his hands and everything else.

Q Obviously it would be very desirable to prevent that use. What I was interested in was whether you had come across instances of it being accidentally or carelessly used in that way and yet no particular harm had been done?

--- That is true.

Q Or any harm?

--- We have found no harm. In those investigations in the garages it was splashed round on hands and faces rather indiscriminately. The dye of course tends to keep it from being used quite as much as other gasoline.

Q That is the intention?

--- Yes.

Dr Le_ake

Dr BRIDGE: In regard to these regulations in the garages, am I quite clear that they were directly mainly to the general health hazards? ^{gases} Yes. I mentioned carbon monoxide in answer to Sir Frederick Willis: you will see that there is another fact that was not apparent to me at first: danger from gasoline itself. We had not a few instances of people being fatally overcome by the fumes of gasoline, used possibly in a confined space; and in the Southern States petrol is used, apart from ethyl gasoline. In certain parts of the Southern States temperatures are a little higher than they are here. Our gasoline is shipped in large tank cars; and I will give you an illustration of what happens with these casuals - tramps I think you would call them here. Supposing a sudden shower comes along, the only thing these men can get into is one of these empty tank cars, which they do; and as they come to the filling platform, not infrequently dead tramps are found in these cars, who have been overcome. Of course the cars are empty, but they are lined with moist petrol, and the fumes have overcome them.

Q Does that give rise to your suggestion for the ventilation of the garage, in addition to the C.O.? --- Mes; but the C.O. was the important thing.

Q Have you any view as to the possibility of lead poisoning from the scrapings from the engine? --- That has been thought of. Of course a great many theoretical ideas could be held about the rate of evaporation and the dust in various ways, from the engine exhaust. We thought

26 (top)

general health hazards? Q -- Yes. I mentioned carbon monoxide in answer to Sir Frederick Willis: you will see that there is another fact that was not apparent to me at first: danger from gasoline itself. We had not a few instances of people being fatally overcome by the fumes of gasoline, used possibly in a confined space; and in the Southern States petrol is used, apart from ethyl gasoline. In certain parts of the Southern States temperatures are a little higher than they are here. Our gasoline is shipped in large tank cars; and I will give you an illustration of what happens with these casuals - tramps I think you would call them here. Supposing a sudden shower comes along, the only thing these men can get into is one of these empty tank cars, which they do; and as they come to the filling platform, not infrequently dead tramps are found in these cars, who have been overcome. Of course the cars are empty, but they are lined with moist petrol, and the fumes have overcome them.

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Dr Leake

I think you call them; but we thought that all these matters would be covered by such an investigation as this. Just which is the most important, we do not know.

Dr BRIDGE: Thank you.

Sir WILLIAM WILLCOX: Dr Leake, you approached this investigation from the point of view of medical men?--- Yes.

Q And you were keenly on the lookout for any symptoms of illness from lead tetra ethyl? --- Yes.

Q You agree that lead tetra ethyl acts therapeutically in a different manner from inorganic lead and that it tends to cause insomnia, nausea, low blood pressure and so on?

--- Which are not commonly found in ordinary lead poisoning.

Q Yes. --- I do not think we can state, however, that that is different from severe acute lead encephalopathy such as we get in our country, at any rate not infrequently in our lead exposure, but of course very much less frequently than the ordinary forms of lead poisoning.

Q The point I wish to make is that lead tetra ethyl produces symptoms different from chronic lead poisoning? --- Acute poisoning from lead tetra ethyl certainly does.

Q Yes. And the mild cases of the acute tetra ethyl poisoning display symptoms which are very different from those of ordinary lead poisoning? --- Yes.

Q I take it that you agree with these symptoms given by Dr Kehoe. (Indicating green volume). --- Yes: he has got much more experience than I have.

Q They correspond with what you have mentioned? --- Yes.

Q There is very little evidence really as to what are the

27 (top)

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Q They correspond with what you have mentioned? --- Yes.

Q There is very little evidence really as to what are the symptoms caused by very minute amounts of lead tetra ethyl, the cases being described either as acute cases or sub-acute cases? --- Yes.

Q Judging from its action in the acute cases, it would appear that it would probably act more specifically on the central

Dr Leake

nervous system than inorganic lead? --- That is so.

Q I take it that dangers from lead tetra ethyl, as such, would be partly from skin absorption? --- Yes.

Q And partly from the swallowing of the vapour and in the inhalation of it? --- We feel that inhalation and skin absorption are the important things. *in tetra ethyl lead*

Q Did you conduct any experiments to show whether animals exposed to the vapour of ethyl petrol were affected in any way as regards their nervous system, or liver, kidneys, heart and so on? --- I have done no animal experiments whatever.

Q There are ~~some~~ ^{few} recorded. --- I cannot state this on my own close observation, but there are a few instances showing that these men who have mild forms of poisoning tend to gain weight after they recover from exposure. That is rather a peculiar instance.

Q That sometimes occurs in alcoholic cases. You have made no detailed observations of the urine or the feces? --- None whatever. The reason the urine was not examined was because it was believed that the excretion of lead through the kidneys was somewhat more uniform than when via the bowels, the liver and so forth: that any great differences in any two groups as regards lead exposure would be shown more clearly by differences in the fecal lead than by differences in the urinary lead; and being pressed for time, we would rather examine a large number of men than examine half the number in both the urine and the feces.

Q You agree that the lead which is excreted in the urine must come from lead which has been absorbed into the system?

--- Yes. In that respect urinary lead is more significant.

28 (top)

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- Q You agree that the lead which is excreted in the urine must come from lead which has been absorbed into the system? --- Yes. In that respect urinary lead is more significant.
- Q And you would agree that if inorganic lead is taken through the mouth -- for instance, sugar of lead -- there is a very small proportion of it absorbed? --- Yes.
- Q Therefore if you find lead in the feces, you are measuring

(a) the lead which is excreted, and (b) the lead which may have been present in the urine but which has not been absorbed? --- All you can say about the lead in the feces is that there has been exposure, not necessarily lead absorption

Q I quite agree. These experiments are extraordinarily difficult, are not they, for determining these minute amounts of lead absorption? Really to have an effective control one ought to analyse the food to see if there is any lead in the food taken; you ought to do that? --- Yes.

Q I have been looking at the details in your report: take group D. That is one of the groups exposed to ethyl petrol: that does give higher figures for the lead in the feces than the other groups? --- Yes.

Q There was definite positive evidence there? --- Yes.

Q But there was really little or no difference between Groups A & B, and groups B & C ? --- There was between Groups A & B.

Q Not very much between A & B, was there? --- Well -----

Q Group D. is the one that shows a decided difference: a decided increase of lead; that is by the fetal determinations? --- I think that would be a matter of interpretation. It would seem that C. had more than A & B, and D. had a little more than C.

Q That was the point really? --- Yes.

Q Group D. is the only one that shows a definite increase above A, B & C.? --- D. did show an increase over A, B & C. One might consider that C. showed an increase over A & B.

Q Yes. The figures in table 29 show that

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- Q That was the point really? --- Yes.
- Q Group D. is the only one that shows a definite increase above A, B & C.? --- D. did show an increase over A, B & C. One might consider that C. showed an increase over A & B.
- Q Yes. The figures in table 39 show that 56 per cent in Group D. had percentages of lead of .101 and .3. 13 per cent had amounts varying between .3 and 1: 2 per cent between 2 & 3: there is a decided difference? --- Yes. You notice those curves on page 114?

Dr Leake

- Q Yes, I did notice them. You agree that when you have any toxic substance acting in any small amounts, it might be rather difficult to discover any ill effects caused by them? --- Quite so.
- Q For example it happened in this country in the case of the beer poisoning epidemic: it was some time before it was discovered that arsenic was the cause; and in the case of the aeroplane workers, ^{where} tetra chlor-ethane was used, it was some time before it was found that this increased illness amongst the aeroplane workers was due to the tetra chlor-ethane? --- Yes.
- Q Therefore you thought it desirable that observations should still continue? --- Yes.
- Q So that any hitherto unrecognised group of symptoms which might be due to tetra ethyl lead in ethyl petrol might be brought to your notice? --- Quite. We still think, Sir William, that, whatever difference there might be in its action from ordinary lead, the lead would be an index of anything that we could find.
- Q Quite. In this problem one is dealing with two problems really: one, the lead tetra ethyl, its toxic effects; and the other, the inorganic compounds of lead produced by combustion? --- Yes.
- Q The latter one is familiar with as regards its toxic effects? --- Yes.
- Q But the former one is somewhat rather in the dark about? --- Yes.
- Q You will agree that sometimes with these toxic substances it is the unexpected that happens? --- Quite.
- Q For example, ladies used tetra chloride carbon (?) for shampooing their hair, and it was not until one tragic occurrence that the danger was realised? --- That is so.

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Q For example, ladies used tetra chloride carbon (?) for shampooing their hair, and it was not until one tragic occurrence that the danger was realised? --- That is so.

Q I suppose that the ethyl gasoline used in America is coloured? --- Yes: it is coloured red.

Q So that people will not be likely to use it for cleaning clothing or cleaning articles which might be stained by it? --- Well, we hope not.

Dr Leake

Q The dye would effectually prohibit it from being used to any extent? --- To any great extent.

Q Probably the lady who used it for cleaning floors got into serious trouble for staining the floors? --- No doubt.

Sir Wm WILLCOX: Thank you.

Sir ROBERT ROBERTSON: There is one point on the proposed regulations for motor garages that you suggested: this deals with ventilation and general cleanliness, except one phrase where it says: "and not for cleaning and other purposes". I suppose you felt that although there was no definite evidence against it, it would be advisable to take certain precautions? --- Yes. -----

Just as was done in regard to the regulations which just precede it, to which Sir George Buchanan called attention.

Q Yes. But my only other point is this: I do not know whether you have already answered it in what you have told us, when you were saying you were out for the broad effects and not for particular experiments. What I want to ask about is as to whether any undecomposed lead tetra ethyl is found in the exhaust or is found in the crank case oil of an engine that is being dismantled? --- I do not know of any such experiments.

Dr BRIDGE: Is pure lead tetra ethyl allowed to be sold freely in America? --- No, it is not: it is not sold freely but there is no definite legal prohibition on that matter.

31 (top) Q You have no list of poisons in America like we have in England, where you have to sign a book when you purchase them? --- That would be largely subject to the different

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Q. You have no list of poisons in America like we have in England, where you have to sign a book when you purchase them? --- That would be largely subject to the different States, except the Harrison Narcotic Act which is a Federal Act.

Q. Would lead tetra ethyl be in it? --- No, that is not in it. There are numerous other poisons made at chemical places which are practically dangerous.

Dr BRIDGE: Thank you.

Dr Leake

PROFESSOR DIXON: I suppose the only trouble about lead is that it is cumulative? --- That is what we have been afraid of.

Q If it were not cumulative, there would be no difficulty of any kind? --- That is so.

Q Could you just tell us what you mean by "cumulative"? --- That instead of an effect appearing soon after the ingestion or absorption of the poison, the effect is, as one may say, sub-clinical: it is not apparent but is produced after long exposure, or prolonged ^{absorption} ~~absorption~~ only; and we think, in regard to lead particularly, of course, that it is actually accumulating in the body.

Q Would this be a good definition: A cumulative poison is one in which the rate of absorption is greater than the ~~excretion~~ ^{excretion}? --- I think so: provided the effect were due to the presence of the poison in the organism and not to simply the mode of entry, or the specific action. It might theoretically be stored in such a way as to be free from any chance of giving harm thereafter, even if it were a large amount.

Q In regard to these garage workers, in your answers today you have told us that the lead in the feces is only an index really to the fact that the man is taking lead? --- That is all.

Q Where does he get his lead from? --- The garage worker?

Q Yes. --- We should like to know. We have hinted at various things: whether it is the lead paint on the cars or the lead from the tyres.

Q Does not the dust of the garage contain lead? --- The dust of the garage contains considerable lead.

Q Would not that be easy to indicate? --- Oh yes; but I cannot

32 (top)

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- Q Where does he get his lead from? --- The garage worker?
- Q Yes. --- We should like to know. We have hinted at various things: whether it is the lead paint on the cars or the lead from the tyres.
- Q Does not the dust of the garage contain lead? --- The dust of the garage contains considerable lead.
- Q Would not that be easy to indicate? --- Oh yes; but I cannot decide as to where that dust came from.
- Q I see. Supposing it was a dusty garage and the man was absorbing the lead, how would he absorb it? --- We think the important thing as to lead is inhalation.
- Q Just what do you mean by "inhalation"? --- As to its further

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- Q Do you mean through the lungs? --- Whether it is through the upper respiratory track or the lungs I am not prepared to say; but that it gets in actually through the air.
- Q But there have been some experiments with dusts and lead dust both in America and Germany, and they show that if you inhale dust, 72 per cent goes through the alimentary canal? --- Yes.
- Q And only 12 per cent through the lungs? --- It might be that you would have at least three routes: the alimentary canal, the lungs and the upper respiratory track.
- Q Supposing you get people who suffer from chronic lead poisoning and that the source of lead has been stopped completely, and then you examine these people's feces and urine a fortnight after - after all lead ingestion has stopped - do you know what the proportion of lead in the feces and urine would be? --- I should think it would vary greatly in different individuals, with their habits and diet and so forth; but lead would continue to be excreted.
- Q Yes; but in what amounts - by the two ways? --- Presumably more by the kidneys than by the bowels.
- Q Well, they are said to be more or less equal, you know; I thought perhaps that was a reason why you adopt the fecal method, because the urine stops extruding altogether periodically, and then goes on. It is irregular, or is said to be? --- Yes.
- Q I did not know whether you had done experiments showing that fact? --- I have not.
- Q But you agree with us, do not you, that fecal lead is not any criterion really of anything except that the man is

33 (4) P 2

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- Q I did not know whether you had done experiments showing that fact? --- I have not.
- Q But you agree with us, do not you, that fecal lead is not any criterion really of anything except that the man is taking lead through the mouth? --- That is all.
- Q Have you any idea, supposing you administered to a man, say, a third of a gram of lead acetate, how much of that lead would be absorbed? --- No, I have not.
- Q It would be a very small amount? --- Yes.

Q This acts on the central nervous system.

I feel sure that I agree with everything you said --that in acute lead poisoning from the acetate you get a stimulant action on the central nervous system entirely different from anything that is known with inorganic lead? --- Yes.

Q Do you remember those cases of the four men which were reported in the Journal of _____? --- Yes.

Q The four men who died from acute ethyl tetra lead poisoning? --- Yes.

Q Two of them died quickly and two after a month, or something like that? --- Yes.

Q The two who died quickly had volatile lead in the brain, and the two who died later had none.

What is your view as to that? I think this bears on the subject that I am asking about. --- I presume that the volatile lead - presumably lead tetra ethyl, in case that was the poison- does not stay in the system and does not stay in the brain but is changed -----

Q Is oxidised? --- Yes.

Q Then you get ordinary lead? --- Then you get ordinary lead.

Q Do you think it likely, if you did absorb lead tetra ethyl in the minute quantities, which are the only quantities we can absorb in practice - accidentally - that the substance would remain unoxidised? --- It certainly does not seem so.

Q You cannot detect it in the body after it has been

absorbed in those circumstances? --- No, you cannot

34 (top)

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Q You cannot detect it in the body after it has been absorbed, in those circumstances? --- No, you cannot.

Q Sir William Willcox suggested to you that chronic lead tetra ethyl poisoning - very small quantities absorbed over a prolonged period - might affect the

Dr Leake

central nervous system in some curious and unusual way, and he gave other examples. Do not you think you have had enough time now in the United States to have exploited any such possible accidents? --- One would say possibly not beyond reasonable doubt; but beyond much doubt. The position in regard to this is somewhat different from that in regard to aeroplane dope and some such things as that: the whole population is pretty well warned, as far as the Health Officers are concerned, to look out for anything; and various unusual things are shown sometimes.

Q It has been suggested to us that America is perhaps not in such an advantageous position as the United Kingdom for investigating these cases of lead poisoning, which occur haphazardly.

--- It is true that in regard to industrial control and industrial medicine such control is not as centred or as uniform or as thorough throughout the country in the United States as in the United Kingdom, but as regards other cases of illness which may come on, and be unusual, I believe that the difference is not very marked and might be one way as well as the other.

35 (4p)

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Mr PYE: Dr Leake, it has been said that the specific effect of tetra ethyl lead on the central nervous system is a thing that would not show up at all in experiments on animals. Although you yourself have not done any experiments on animals, would you say that that is so: that the experiments on animals that have been done are quite valueless -- have been and always would be quite valueless as indicating any possible effect on the human central nervous system? --- I do not think they can be considered as quite valueless, but what we would be afraid of and what would be the hardest to detect would be the subjective symptoms, which we could not get, of course, in animals. And naturally the symptoms might be different in one species from those of another; but the animal experiments would certainly give a very good idea of what would be expected in the human.

Q Even symptoms of a nervous type? --- Even symptoms of a nervous type.

Dr LANDER: I have no questions, thank you.

Sir CHARLES MARTIN: Dr Leake, you told the Chairman that your Service has been unable to discover instances of lead poisoning from the use of ~~tetra~~ petrol containing one part in 1300 of lead tetra ethyl; but it has been suggested to this Committee by another witness that cases have really occurred and that they have been hushed up and compensated by presumably important interests concerned. Do you think that that has been the case? --- That could hardly be the case with the sort of injuries for which we are looking: that is in the general public. They might

36(100)

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- Q No, no, I mean in the garages? --- In the garages in general you mean?
- Q Yes? --- Those people are not subject to such control by the interests whose product is at stake, so that it could be hushed up. The use is quite general in the United States and there are all sorts of garages and private car drivers as well who are using it. It is inconceivable, if a considerable number were occurring, that that would account for our not hearing of them.
- Q Is industrial lead poisoning compensatable by law in the United States? --- In the Industrial States.
- Q I mean a man working in an accumulator factory for instance gets lead poisoning? --- In the States which have such a law. Of course, our States vary: some States have no compensation law.
- Q Supposing in such a State a garage worker suffered from incipient lead poisoning from the use of ethyl petrol, would he have a case against his employers? --- It might be so interpreted by the Courts. I think that is so.
- Q I have one other question to ask you: that is that considering the toxic character of lead tetra ethyl, with which you were familiar when you started your investigations, were you not surprised to find that you could get no evidence to convict it when used as ethyl petrol? --- Yes.

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SIR CHARLES MARTIN: Thank you.

CHAIRMAN: Thank you very much, Dr Leake.

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SIR CHARLES MARTIN: Thank you.

CHAIRMAN: Thank you very much, Dr Leake.

(The Witness withdrew).

Dr GRAHAM EDGAR recalled.

CHAIRMAN: Dr Edgar, we have asked you to come this morning because there are one or two questions arising out of some further evidence that we have had bearing on the evidence which you gave us. Some of us thought that we might put a very few questions to you in regard to these points. First of all, it was objected before us that there was something sinister in what you have done in the United States in calling this material tetra ethyl lead instead of lead tetra ethyl. I do not know whether there is anything in that? --- As a matter of fact, I do not know the official nomenclature of the American Chemical Society, but looking up the references in the literature, I think that in nine-tenths of the technical journals tetra ethyl lead is used rather than lead tetra ethyl. As a matter of fact it is customary in the United States to refer to the organic compounds more frequently by putting the ~~organic~~ metal last: for instance, they call it di-ethyl ^{selenium} ~~chloride~~ rather than ~~chloride~~ ^{selenium} di-ethyl: and from my own experience in the matter I have always known it as tetra ethyl lead, but I can hardly conceive of there being anything particularly sinister in calling it tetra ethyl lead.

Q You did not change it round in order to obscure the fact that you were using any particular material? --- I cannot see that at all. It seems to me that lead tetra ethyl is the same as tetra ethyl lead.

Q Then it is said that the name ethyl does not contain the word lead at all? --- The term ethyl -- we pronounce it

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- Q You did not change it round in order to obscure the fact that you were using any particular material? --- I cannot see that at all. It seems to me that lead tetra ethyl is the same as tetra ethyl lead.
- Q Then it is said that the name ethyl does not contain the word lead at all? --- The term ethyl -- we pronounce it ethel -- was adopted as a registered trade mark for the brand of anti-knock compound used by the Gasoline Corporation. As a matter of fact in most cases, I believe, there is no necessary relation at all between the chemistry of the compound and the name of the material used for trade

purposes. You see that continually: that various names are adopted in the sale of materials, and I do not think there is any particular reason why we should even put the ethyl in. I was not a member of the Corporation at the time the wording was adopted, but I imagine that someone selected it as being perhaps the most euphonious word of the three: tetra ethyl lead. Certainly there has been no attempt to conceal the fact that ethyl gasoline contains tetra ethyl lead, both in the advertisement and in the descriptive circulars which the Corporation have given very wide circulation, ^a full explanation has been given of the fuel and of tetra ethyl ^{lead}. Therefore I cannot see any significance in the use of the word ethyl.

Q Then there is quite a small thing. I think you feel it is the most usual way to refer to the compound as so many parts by volume rather than by weight? --- As a matter of fact in the early days ethyl fluid was added to petrol in a small device long since abandoned, ~~in which~~ a certain volume was measured out for every given volume of gasoline, and consequently the normal way of referring to it was ~~only~~ on a volume basis. The volume basis is more commonly ^{with liquids} employed than the weight basis. In the case of benzole you speak of 20 per cent benzole or 40 per cent benzole. That is always per cent by volume and not by weight. It would not be the same percentage by weight. There is another legitimate reason why volume should always be employed in this particular case. We say that we use a maximum of one part in 1300 by volume. That is a thing you can get exactly. You measure a certain volume of ethyl

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Dr Edgar.

- Q You use the words "by volume"? --- Quite. We have always spoken of it as by volume.
- Q Some objection was taken before us to the method that was adopted for obtaining the controls in some of your experiments. You collected a lot of people at random through an employment agency? --- In the earliest of the four investigations which were carried out in this matter, namely the one that was carried out by Dr Kehoe, myself and others --- the one just preceding the investigation of the Surgeon General's Committee --- that method of selection of controls was ~~was~~ started, and it was a perfectly valid criticism there that the controls were not strictly comparable with the others. It must be remembered, however, that at that time the Ethyl Gasoline Corporation had no convenient way of getting controls exactly corresponding to the men in question. You cannot go to a man who is employed by a rival brand of gasoline and say: "We wish 20 of your employees to be put at our disposal for investigation", and we had no means of getting the particular men for that purpose. Therefore, we adopted what we thought was a fairly reasonable way: we selected them at random from employment exchanges, and paid them five dollars for the privilege of examining them and examining their urine. So I do not think that that particular method of selection has any bearing on the particular nature of the group. The important conclusion was that none of the men were suffering from lead poisoning, yet practically all the excreta showed small quantities of lead, in

40(4p)

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Q I think you rather wanted to say something to us about what has been termed the specific effect of tetra ethyl lead on the central nervous system? --- Yes. That has

been mentioned. As I said before, I am not a physiologist and I have great hesitancy in expressing an opinion in the presence of skilled physiologists; but it does seem to me that we are assuming a specific effect of tetra ethyl lead, taken in very small quantities, which is to say the least, improbable. And even in the case of acute poisoning there was some doubt as to whether there was a true specific effect of tetra ethyl lead. But assume that there is a difference in the case of acute ~ poisoning, I think it is rather unlikely that the specific effect should persist in the very minute doses that one could conceivably get of ethyl petrol. Certainly one's experience in other products would not bear that out. In such a case as prussic acid and carbolic acid -- which I think would be said to have specific effect in large concentrations, but when taken in minute doses they are oxidised or otherwise treated, without producing specific effects. Tetra ethyl lead is ^avery readily oxidisable substance, and it would be my own feeling that the probability is that taken in minute quantities the body would convert it into inorganic lead compounds, so that you would not get a specific effect. So although it is not capable of proof, perhaps, I think the assumption that there are specific effects from minute quantities of tetra ethyl lead is more improbable than otherwise.

41 (top)

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Dr Edgar

Q One of the witnesses said that this Committee could not answer the questions they have been asked under twenty years and possibly not then. --- Well, predictions as to what may happen in ten, twenty or fifty years are very easy to make and very difficult to prove or disprove, particularly with the material in question. Obviously it is impossible to answer as to what will happen in a great number of years. The same arguments might be used for almost anything. Take benzol: we know that benzol is poisonous; many people die from it, and chronic poisoning has been produced. It might easily be argued that the use of benzol in petrol in a certain given time would result in universal poisoning. I do not think that has been the case. It seems to me that the suggestion that this, that or the other may happen in any number of years, unless it is backed up by more definite evidence than I have myself heard, is of little value: of course it is easy to make.

Q Do you think that the four or five years' investigation that has taken place gives no indication for thinking that anything serious is going to happen in fifteen or twenty years? --- From what little I know of the subject myself, I certainly feel that if there is no progressive change in five years, the chances of anything measurable developing in ten or fifteen, or any number of years, will be excessively small.

Q It is a matter of argument, of course. You have heard perhaps the questions we put to Dr Leake this morning as to whether these garage workers who have been selected for

happen in ten, twenty or fifty years are very easy to make and very difficult to prove or disprove, particularly with the material in question. Obviously it is impossible to answer as to what will happen in a great number of years. The same arguments might be used for almost anything. Take benzol: we know that benzol is poisonous: many people die from it, and chronic poisoning has been produced. It might easily be argued that the use of benzol in petrol in a certain given time would result in universal poisoning. I do not think that has been the case. It seems to me that the suggestion that this, that or the other may happen in any number of years, unless it is backed up by more definite evidence than I have myself heard, is of little value: of course it is easy to make.

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Q It is a matter of argument, of course. You have heard perhaps the questions we put to Dr Leake this morning as to whether these garage workers who have been selected for experiments have been specially warned so that the experiment was invalid. Do you agree with Dr Leake that these men were not specially careful? --- Dr Leake has very much more experience than I have, but I can speak of the first investigation that was carried out by Dr Kehoe and myself:

Dr Edgar

certainly there was no evidence in that of any particular care on the part of any of the men. The petrol was spilt over the hands and over the body, and no precautions of any kind were taken: in fact among those workers who worked at the very start it was very difficult to get them to take any precautions, because they had been working at it for two years and they had not felt any ill effects, and they simply would not believe you when you told them they ought to be careful.

Q One very important thing I think is: To what extent this finding of lead in the excreta is a fair index of whether there has been damage to the person or not. Have you thought about that question or not? --- I have thought a great deal. It is a problem probably incapable of absolute proof. The argument is frequently made that a man has been storing up very large quantities of lead in the body and not excreting it. You could hardly prove that directly without killing the individuals and analysing their bodies for lead.

Q You could hardly do that in this country; I do not know what you could do in America? --- So it is impossible to get direct proof of that kind, but I think that an interpretation of the data - as far as they go - would indicate that the excretion of lead is a fair measure, in any statistical grouping, of the storage of lead. You can get at it in two ways: you can get at it in an unsatisfactory way by animal experimentation: animals have been killed and analyses made, and there is certainly a rough correlation between the excretion of lead and the storage. You can get it by examination of groups of men who are supposed to be specifically storing

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over the hands and over the body, and in fact any kind were taken: in fact among those workers who worked at the very start it was very difficult to get them to take any precautions, because they had been working at it for two years and they had not felt any ill effects, and they simply would not believe you when you told them they ought to be careful.

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Dr Edgar

their excreta is ^{therefore} a rough measure of their storage. So I think a reasonable interpretation of that would be that the excreta is truly a measure of the storage of lead, and the fact that these men are not excreting more lead now than they were two years ago - as is apparently the case - shows that they are therefore not storing lead. That is merely a question of interpretation, but I think it is ^a reasonable interpretation.

CHAIRMAN: Professor Dixon, is there anything further you would like to ask?

PROFESSOR DIXON: I would like to mention one thing, Dr Edgar: that is that your analogy suggesting that tetra ethyl lead is oxidised is of course correct, but the comment that therefore you cannot produce any effect on the central nervous system with small doses is not analogous to other things. Take hydroxide of ethyl and compare it with lead ethyl: you would not say that one glass of whisky had had no effect because it will not make a man drunk quickly? --- Not at all.

Q That is practically what you say about lead tetra ethyl, is not it? --- No.. I would like to go back to my own ^{example} knowledge and take the case of prussic acid.

Q But that is not oxidised. I am taking another, which is much closer allied. --- Is not prussic acid oxidised in small doses to cyanic acid? In small doses is it not oxidised to cyanic acid and excreted? I have read that somewhere.

44 (top)

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Q I do not think there is any analogy there. --- It is quite possible. I have already apologised for any opinions I have given on physiology, because I only get these things from reading.

Dr Edgar.

Sir WILLIAM WILLCOX: Dr Edgar, you said you did not think lead tetra ethyl in small quantities would have any ^{specific} action because it is oxidised? --- I think ^{it is} probable.

Q You are not a toxicologist nor a physiologist? ---
I am not: I am merely reasoning from general analogy, via chemistry, being a chemist.

A It is merely theoretical? --- Quite.

Q Let me give you another example: arseniureted hydrogen? that is poisonous in very small quantities? --- Yes.

Q That is even more readily oxidisable than lead tetra ethyl? --- Yes.

Q And that ^{has an effect} collects in minute quantities? --- Yes.

Q The whole question is whether the drug is a poison as such? --- Perhaps I may have been misunderstood. My statement was not that there was no specific effect, because I do not know whether there there is a specific effect, but I said that the assumption that there is one is perhaps unnecessary. You want experiment rather than assumption.

Q But you will agree that there are such instances known of things which in very dilute quantity have a poisonous action: for example, arseniureted hydrogen? --- Quite.

Q In more dilute proportions than tetra ethyl lead? --- Yes ; and many others besides arseniureted hydrogen.

Q You did mention in your previous evidence, that lead tetra ethyl has a definite specific action on the

45 (top)

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- Q In more dilute proportions than tetra ethyl lead?
--- Yes ; and many others besides arseniureted hydrogen.
- Q You did mention in your previous evidence, that lead
tetra ethyl has a definite specific action on the
nervous system, rather more so than ⁱⁿ organic lead?

Dr Edgar

--- I think that is a matter that has been referred to this morning. There seems to be some evidence to that effect, but whether that is so or not I do not know. We certainly do get certain of the acute nervous symptoms ^{with} of ordinary compounds of lead: lead ~~oxide~~ ^{oxide}, for example.

You get practically all the symptoms which are ^{observed in} governing acute tetra ethyl lead poisoning occurring from time to time with ordinary lead. So I think it is at least a matter of debate as to whether there is specific action or not.

Q It is not a matter of debate as to what these poor people died from in the works? --- Certainly not.

Q They died from symptoms of brain inflammation?

--- Yes. So according to Legge and Goodby (?) ^{other} 43 per cent of the cases did: at least they did not all die of it but they all showed the symptoms. In one of the later chapters of his book he speaks of delirium and the like: hallucinations of persecution and so on: they were all ^{produced} excited by inorganic lead poisoning.

Q That was especially so with diachylon?

--- Apparently not, according to my reading of it.

46 (top)
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Q But we had a case in regard to carbonate of lead which was mistaken for encephalitis. If lead tetra ethyl acts on the ventral nervous system, it would produce damage to the nerve ^{cells} ~~cells~~? --- Yes, quite possibly.

I could not very well describe the mechanism by which it produces its effect.

Dr Edgar.

Q A nerve cell when damaged recovers very slowly, if ever?

--- It is a matter of which you know much more than I.

Sir WILLIAM WILLCOX: Thank you.

Dr BRIDGE: Has your experience in America of the use of rubber gloves as a protection been satisfactory? --- For concentrated handling of ethyl fluid and pure tetra ethyl lead rubber is not ^{entirely} ~~preferably~~ satisfactory as a protection --- against pure ethyl fluid or pure tetra ethyl lead, because rubberswells in these materials, but it affords temporary protection. The lead will not go rapidly through rubber but is absorbed by the rubber; so that rubber gloves ^{are} ~~were~~ used continually with concentrated material, but it is necessary to change the gloves rather frequently.

Q In other words they last for a time? --- Oh yes. With a rubber glove you can dip your hand in ~~a~~ ethyl fluid and take out your hand and you do not find any fluid pass through, but if you use a glove from day to day it would not be much good.

Q What about ethyl petrol: would you find a glove satisfactory in that case? --- I hardly think ^{it necessary} ~~so~~. As a matter of fact, I do not believe in using anything but my hand in ethyl petrol, but I imagine that a rubber glove would be much more effective in ethyl petrol than it would be in tetra ethyl lead, because the ethyl petrol does not have quite the same swelling effect that the tetra ethyl lead and ~~tetra~~ ethyl bromide would have.

Q In other words the gloves last longer?

47 (top)

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Dr Edgar.

SIR GEORGE BUCHANAN: With regard to the comparison that Professor Dixon has given you, you admitted in answering him that to give a man a glass of whisky might have an effect. If the question was whether a glass of water with 10 drops of whisky would have any effect, would you think that the two were necessarily comparable? --- My guess would be that the glass of whisky would ~~be~~ have a considerable effect and the glass of water with 10 drops of whisky would have none that could be measured.

Mr CHAPMAN: Some people have told us that they are able to tell by the smell of the exhaust gases whether ordinary petrol or ethyl petrol is being used. Could you tell in such a case? --- I think if a man says he can smell a thing it is very difficult to disprove it.

Q Take your own case? --- Certainly I have never smelt the difference ^{between} in gasolines in the exhaust gas, and ^{it is most} ~~the tendency is~~ ^{markedly different} for ~~it~~ to be present, because tetra-ethyl lead is much more readily oxidizable than the petrol, and that it should persist through the combustion of the engine is quite inconceivable. A question was asked this morning about the occurrence of tetra-ethyl lead in the crank case. ^{oil} A question was asked me when I was here before and I said I had no evidence on that point. I have a little bit of evidence which could not be called conclusive. We had an engine which ran 150 hours on ethyl petrol, and which contained in many cases considerably more lead than is used commercially. We drained the crank case oil, examined it for lead by analyses, then subjected it to steam distillation for an hour and a half

46 (top)

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Q Take your case? --- Certainly I have never smelt the difference ^{between} in gasolines in the exhaust gas, and ^{it is most} ~~the tendency is~~ ^{likely to be present}, because tetra-ethyl lead is much more readily oxidizable than the petrol, and that it should persist through the combustion of the engine is quite inconceivable. A question was asked this morning about the occurrence of tetra-ethyl lead in the crank case ^{oil}. A question was asked me when I was here before and I said I had no evidence on that point. I have a little bit of evidence which could not be called conclusive. We had an engine which ran 150 hours on ethyl petrol, and which contained in many cases considerably more lead than is used commercially. We drained the crank case oil, examined it for lead by analyses, then subjected it to steam distillation for an hour and a half, and concentrated the distillate and examined it for lead. We found .47 per cent of total lead in the oil, but no lead in the steam distillate, which certainly would indicate that the tetra-ethyl lead does not occur in the crank case oil. That is only an isolated case and I give it for

what it is worth.

Q There are many cities in the United States where a very large numbers of cars are using this ^{petrol} ~~oil~~: have you had any complaints at any time in regard to the smell? --- I have been told that ^{people} ~~most~~ can smell a difference in the exhaust when they are running on ethyl petrol from when they are not. We made experiments on this line. We have run a car on pure tetra-ethyl lead. That is tetra-ethyl lead in petrol with no bromide or other material added. In such cases they have never been able to detect a smell. On the other hand if we take a small amount of di-ethylene bromide the same people get the same smell as they do from the ^{ethyl} ~~tetra-ethyl~~ petrol: consequently I expect that that is to be attributable to traces of bromide compound and not to the presence of lead.

CHAIRMAN: But whether you can smell the tetra-ethyl or not, is it more offensive? --- Personally I could not tell the difference. But that is a matter of opinion.

Q I have again and again come across people who say: "Oh, that car in front is burning ethyl petrol: what a beastly stink"? --- I was informed by a ^{gentleman} ~~German~~ only the other day that he had been using ethyl for some time, and he was driving some friends out in a saloon car, and the man in the back seat began to comment on the fact that the fumes of ethyl petrol were ^{gentleman} ~~injuring~~ him. This ^{but} ~~German~~ said: "Oh, it is not burning ethyl petrol" -- he had not been able to get any ethyl petrol on that day and he was burning something else.

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So you see you cannot always tell by a casual opinion.
PROFESSOR DIXON: Would the bromide cause that smell? --- The bromide compounds are in very minute quantities. But minute traces of bromide compounds are rather detectable by smell.

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PROFESSOR DIXON: Would the bromide cause that smell? --- The bromide compounds are in very minute quantities. But minute traces of bromide compounds are rather detectable by smell.

SIR WILLIAM WILCOX: As regards the immediate effects, I think everyone has agreed that the danger from carbon monoxide is immeasurably greater than lead? --- I should certainly think so.

CHAIRMAN: Thank you.

(The Witness Withdrew)

(The Committee Adjourned)