December 27, 1944

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Dr. Charles H. Erway,
Eclipse Machine Division,
Bendix Aircraft Company,
Elmira, New York.

Dear Dr. Erway:

I am sending you herewith a memorandum which covers the results of my observations at the time I visited your plant, together with certain recommendations and some suggestions also with respect to methods of procedure.

I trust that this will be of use to you and your associates, but if there is anything further that I can do, please do not hesitate to call upon me.

For the sake of my own convenience in avoiding records and bookkeeping I am sending you also an account of my expenses plus a fee for my services. The low traveling expense is occasioned by the fact that I was in Buffalo on other business. I trust that this will all be satisfactory.

I shall be very much interested in knowing the results of any observations that are made and also of the practical conclusions that are worked out in preparation for your enlarged operations. I should also be glad to know the impressions that resulted from the visit of some of your people to Wright Aeronautical.

I enjoyed very much making your acquaintance, and it was a pleasure to meet and discuss the situation with you and your associates. I trust we shall have the opportunity of meeting again.

Sincerely yours,

Robert A. Kehoe, M. D.

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Enc.

KE 0005236

N 7289

Robert A. Kehoe, M. D.
College of Medicine Eden Avenue
Cincinnati 19, Ohio

December 27, 1944

Eclipse Machine Division,
Bendix Aircraft Company,
Elmira, New York.

Attention: Dr. Charles H. Erway

Fee in connection with visit to plant on Friday, December 15, including report	$100.00
Traveling Expense	17.71
	$117.71

KE 0005237

N 7289.01

Expenses in connection with trip to
Elmira, New York, Dec. 15, 1944

R. R. (coach) Buffalo to Elmira and return	$7.13
Hotel - 1 night	4.00
Meals	3.00
Taxi, etc.	1.85
Incidentals	1.33
Total	$17.31

KE 0005238

N 7289.02

MEMORANDUM ON VISIT TO ECLIPSE MACHINE DIVISION BENDIX AVIATION, ELMIRA, NEW YORK

This plant was visited on December 15, 1944 for the purpose of examining into the toxic hazards of exposure to the ingredients of high octane gasoline (100 octane aviation) on the part of men engaged in testing the performance of fuel distributing pumps for aircraft motors. The present temporary facilities for this work were examined and the performance of the work was observed. Afterward in a conference the means of protecting workmen in a projected building designed for this work, were considered.

Hazards and Their Control (in principle)

The hazards of fire and explosion were not the subject of consideration but were merely mentioned in passing in connection with the employment of local exhaust ventilation for the removal of gasoline vapors. The possibility of the carriage of explosive mixtures in air through ducts and motorized fans was referred to as a special problem requiring expert engineering experience as to the means of avoiding static electrical accumulation especially in cold weather, and preventing ignition of vapors by operating electrical equipment.

The toxic hazards that must be dealt with are those associated with the vapors of mixed hydrocarbons and of tetraethyl lead. Both of these may reach significant proportions, and therefore the conditions which influence their magnitude must be understood.

Toxic Exposure to Hydrocarbons

The toxicity of modern aircraft engine fuels is considerably higher than that of motor fuels commonly in use some years ago, the

latter having been composed chiefly of the products of simple distillation of petroleum. Modern cracking, alkylating and reforming processes result in the presence in aircraft fuels (and in other high compression motor fuels) of various hydrocarbons of much greater toxicity than those produced by simple distillation. The situation may be illustrated by the fact that the tolerable concentration of naphtha or ordinary gasoline distillates in air for prolonged human exposure is generally accepted as approximating 1000 p.p.m. by volume, while that of certain aromatic hydrocarbons commonly found in 100 octane gasoline (up to 12 to 14 per cent by volume) is not greater than 200 p.p.m. by volume. Moreover the irritating effect of skin contact with the high octane gasoline is greater than that of commercial gasolines generally available in an earlier period. The result of these facts is that much greater care must be taken to control the spillage and vaporization of 100 octane gasoline and to avoid skin contact therewith, than would have been required to produce an equivalent degree of safety in the handling of ordinary motor fuels of this or an earlier period.

An additional fact of considerable practical importance has just come to light as the result of certain recently and confidentially reported observations on the vaporization of gasoline. Gasoline vaporizes into an air-stream conducted over it with remarkable speed. As a consequence of this fact the rate at which the air moves has relatively little effect upon the concentration of gasoline arrived at in the air stream. Therefore, <u>the frequency of air-changes in a ventilated space in which gasoline is handled in open containers or spilled, is not the important factor in the</u>

control of the concentration of gasoline vapor. Rather the important factor is the extent of the surface of gasoline that is in contact with the air stream. It follows, therefore, that (1) openings by which air may come in contact with gasoline in a ventilated space must be reduced to the minimum; (2) spillage of gasoline must be controlled with extreme care; and (3) the spraying of droplets into the air from any source must be prevented. For the control of such exposure as may otherwise occur through the operation of any of these factors, vapors should be removed from the space by being picked up at their point of origin and conducted to the outside. By these combined methods of control the concentration of gasoline vapors in air must be kept below 500 p.p.m. at the least. It is believed that few persons unaccustomed to exposure to 100 octane gasoline will fail to develop variable degrees of discomfort if exposed for hours per day to air containing 500 p.p.m. of such vapor. For this reason it is advisable to achieve the maximum freedom of the air of workrooms from such vapor.

The equipment to be used should be so designed as to diminish to the minimum the need for contact of the skin of workmen with gasoline. Facilities for cleansing the skin thoroughly at mealtime and other suitable intervals should be provided and all workmen should be advised of the need for meticulous cleanliness. Where feasible, a barrier cream may well be used, and in any case the use of a grease cream (for oiling the skin) should be available for use following thorough washing after routine contact with gasoline in the course of work. These procedures are recommended for the purpose of preventing dermatitis as the result of contact with

petroleum hydrocarbons. Such dermatitis is rarely serious but may cause considerable interruption in the work of individuals. Obviously, care against contamination of clothing with gasoline must be taken to avoid much more serious injury to the skin than that occasioned by contact of unclothed skin areas. If conditions require periodic or occasional changes of clothing, suitable equipment (lockers, locker-room, and clothing) should be made available under some well-established regimen.

Toxic Exposure to Tetraethyl Lead

Under the conditions of the normal commercial handling of motor fuels containing tetraethyl lead, no significant risk of lead absorption exists, but certain emergency methods of military handling have given rise to trouble, and certain technical operations, such as the procedures involved in the present instance, have brought about potentially dangerous conditions of lead exposure. These conditions can readily be avoided by the application of certain general principles, and therefore it seems advisable to clarify the factors that influence the extent of the exposure.

The safety factors in the normal commerical handling of leaded gasoline are primarily two in number.

(1) Whereas tetraethyl lead is absorbed through the human skin with fair ease, the dilution of tetraethyl lead with gasoline retards its passage through the skin and prevents it, for all practical purposes, when the dilution is of the order of magnitude of 1000 parts or more of gasoline to 1 of tetraethyl lead. (The concentration of tetraethyl lead in commercial gasoline may not exceed 1000 parts per million, while that in military gasoline, while not under control of the Ethyl Corporation, has not exceeded this figure

except in connection with certain experimental activities of restricted scope.)

(2) From the aspect of inhalation of vaporized tetraethyl lead out of gasoline, the difference in the volatility of these two engredients of motor fuel, together with the difference in their respective concentrations in the mixed fuel, is such that very little tetraethyl lead is given off in the vapors of the fuel when evaporation takes place from an open container. (The first 10 per cent of vaporized fuel contains only a minute fraction of the available lead compound.) As a consequence, if the fuel is handled so as to avoid the undue risks from fire and explosion that would follow from spillage or leadage in enclosed spaces, and so as to prevent the occurrence of toxic concentrations of gasoline in the air breathed by handlers, no risk of toxic lead absorption occurs.

By reason of the operation of these two factors, plus the care currently taken by gasoline distributors to avoid fires and explosions, the commercial handling of leaded gasoline has been unaccompanied by any cases of measurable lead absorption or of lead intoxication over the period of approximately twenty years during which such fuels have been distributed. (Certain conditions peculiar to the confined spaces of gasoline storage tanks, have resulted in some serious cases of lead poisoning among periods who have entered storage tanks to carry out cleaning and repair operations, without following standard precautions. Such cases, which have been reported in medical literature, should not be permitted to confuse the clean-cut issue under discussion.) However, there

can be no doubt that leaded gasoline can be dealt with in such a manner as to give rise to dangerous lead exposure. Three principal factors are responsible for the production of such an hazard, - (a) spillage of considerable quantities of gasoline in an enclosed or partially enclosed space, (b) spillage or leakage of gasoline in a thin layer or on a surface that permits of its complete evaporation, and (c) the creation of a spray with resultant complete vaporization of the gasoline in the air.

It is apparent that all the conditions that may result in the operation of the above factors must be controlled with detailed precision in any technical operation that is intended to continue over any considerable period of time. Lead absorption in relation to such operations must be kept within quite low limits in order to avoid cumulative effects. It has been shown that a reasonable degree of safety can be maintained by preventing the occurrence of lead concentrations in the air in excess of 1.5 mg. of lead (Pb) per 10 cubic meters of air. It is feasible and wise, however, in connection with exposure to gasoline to tighten up this standard by 30 per cent or more, for/so doing the concentration of gasoline available in the air will usually be beneficially influenced. The basis for the use of 10 cubic meters as a standard comes from the fact that this is the upper limit of the quantity of air breathed in by a well developed adult at reasonably hard work in the course of 8 hours. If the working day is longer than 8 hours the permissible concentration of lead must be reduced proportionately.

(Methods for the determination of lead in the air are appended hereto, as a basis for compliance with these standards, and it is recommended that precise measurements be made under the

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various conditions that may exist in connection with present and future operating conditions. It may be unnecessary to make corresponding determinations of the concentration of gasoline vapors. The experience of the men may provide sufficient indication of the significance of the exposure to gasoline. The severity of the lead exposure, however, should not be left to conjecture, unless virtually complete freedom from exposure can be achieved.)

Practical Observations and Recommendations

Observation of the conditions under which the work under consideration is being carried out justifies certain criticisms. While recognizing that the present facilities are temporary in character, previous experience and the present expectation as to the completion of new facilities necessitate the conclusion that present conditions may remain in use for quite some time. Moreover it was said that additional equipment similar to that now in use was to be introduced into the same space. The criticisms, which are not intended to be unduly emphatic but merely straightforward, follow: -

(1) The ventilation of the room in which the work is done is general, rather than specifically fitted to the problem involved. For reasons indicated above this type of ventilation cannot but be ineffective, and it is. If additional equipment is added there will be an increase in the exposure, in direct proportion, at least, to the increase in the number of units. Each unit of equipment employed in the testing should be ventilated individually, in such manner as to remove rather than merely to dilute the vapors that arise from the entire operation.

(2) The inevitable spillage of gasoline should not be permitted to influence the cleanliness of the space in general. All

dripped or spilled gasoline should be caught by ventilated drip pans that will keep the gasoline off the floor and its vapor out of the air in the room. All fuel lines must be kept absolutely tight. At present much too much gasoline lies on the floor. This should be cleaned up completely, and if any opportunity for future spillage is allowed to remain, floor drains and water lines must be available for washing it awey promptly and completely. The use of composition floor dryer to remove gasoline, if that is intended, is unjustified for this purpose. No doubt it is satisfactory for taking up oil, but the presence of dye on the floor clearly indicates the spillage and non-removal of considerable quantities of gasoline.

(3) The apparatus in use is not sufficiently enclosed or free of leaks to provide safe conditions. Several models are in use, presumably as an indication of somewhat less than a satisfactory performance of any. A model should be settled upon as soon as possible, so that makeshift methods can be dispensed with and safety devides introduced to the maximum degree.

(4) The fire hazard to all the men is greatly magnified by the fact that there is no adequate isolation of individual units of equipment. Any further introduction of similar equipment will intensify this hazard, which in the opinion of this observer is already much too great.

It is strongly recommended that observations be made to determine the extent of the lead absorption of certain of the individuals who have been engaged in this work, or whose exposure in the developmental process resembled that of the present operators. Samples of urine and blood can be obtained and analyses can be made that will result in demonstrating the degree of significance

of the lead exposure that has occurred. Such observations will give a clue to the present need for precautions and may well point the way to what should be done in the new building that is to be built. If the ground work is properly laid for the collection of these samples, so that their value and prupose is understood, it seems improbable that they will create difficulty. Our previous rather broad experience in this regard has given us little or no reason to fear the reaction of reasonable men. It is recognized that the occasional man is not or does not wish to be reasonable. Careful selection of men for this purpose should obviate any difficulty along this line. If and when the number of persons to be examined in this way is determined, we shall send all the necessary containers and complete instructions.

With respect to the new building that is to house this work, it is recommended that the plans for the installation of the testing and ventilating equipment be reviewed in the light of this discussion of hazards and the principles of their control. Indeed, it is understood that this is being done and that this recommendation is merely a confirmation of verbal statements. It is hoped that the visit to the Lockland, Ohio, plant of Wright Aeronautical Corporation was productive of useful information in this direction.

From the Kettering Laboratory of Applied Physiology, College of Medicine, University of Cincinnati, Cincinnati, Ohio.

Robert A. Kehoe, M. D.,
Director

December 27, 1944