

THE ASSOCIATED ETHYL COMPANY LIMITED

Registered Office: THE ADELPHI, LONDON, W.C.2

Address all communications until further notice to:

ARTILLERY HOUSE, ARTILLERY ROW, LONDON, S.W.1

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OUR REF.

O/af

YOUR REF.

10th August, 1943.

Dr. Robert A. Kehoe,
College of Medicine,
University of Cincinnati,
Ohio, U.S.A.

Dear Bob,

Further to my letter to you of 29th July, on the subject of sickness among men filling gasoline cans, I now enclose copy of a memorandum prepared by Dr. Cassells, as a result of an examination he carried out recently to determine lead in the atmosphere in a similar type of can-filling plant in this country.

We are considerably worried by the high figures for lead content and although there have been no reported cases of sickness at any plant in this country, we feel that steps must be taken immediately to bring about a substantial improvement in the ventilation at all such plants. By reason of existing conditions this is by no means an easy matter and before we engage upon any elaborate or major alterations I am most anxious to receive your views.

For the immediate moment we are doing all that we can to a) reduce spillage to a minimum; b) increase natural ventilation to a maximum; and at the same time the oil companies concerned are making a detailed study of what would be required at each plant should it be considered essential to install forced ventilation.

We have not yet received any further information from Abadan, but it is expected that something may arrive sometime in the near future.

I would much appreciate your letting me have your comments on this problem, at your earliest convenience.

All best wishes and kindest regards,

Sincerely yours
Ray Bevan

JERRY - CAN FILLING

INVESTIGATIONS CARRIED OUT AT STANLOW REFINERY - JULY, 1943.

PURPOSE OF INVESTIGATION:-

To determine whether the operators were running any risk of lead poisoning from the inhalation of lead during the operation of filling jerrycans with leaded gasoline.

INVESTIGATION.

1. BUILDING:-

The building in which the filling takes place has a cubic capacity of 1169 cubic metres. Its dimensions are indicated on the accompanying rough ground plan, and it forms part of a large building.

The floor is of concrete and the operators stand on a slightly raised wooden platform at the filling bench.

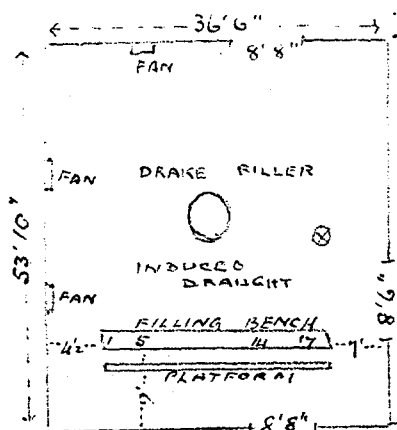
There are three doors, as shown on the plan, one communicates with the rest of the building: the other two open to the outside air and have blast walls.

Three extraction fans are set in the outside walls, as indicated.

Over the Drake Filler in the centre of the building there is slightly induced draught.

The top of the filling bench is of wood, $2\frac{1}{2}$ inches thick.

No washing down with water is done.



LENGTH - 36'6"

BREADTH - 53'10"

HEIGHT TO
EAVES - 16'6"

EAVES TO
TOP - 9'2"

CUBIC
CAPACITY - 1,169 cubic
metres

2. OPERATION OF CAN FILLING:-

The operation involves the filling, by hand control, of a 4-5 gallon can with 100 octane leaded gasoline (4.8 c.f.s. tetra ethyl lead in each gallon of gasoline). The filling is carried out by two shifts of 18 women each. The first shift works from 6 a.m. to 2 p.m.; the second from 2 p.m. to 10 p.m. No filling takes place at night. It is calculated roughly that 1,200 cans are filled per hour from 18 filling points.

A swivel tap is brought down into the mouth of a can on the filling bench and the flow of gasoline is controlled by a hand lever. When the can is seen to be full, the flow is shut off, the swivel tap is swung up, the cap of the tin is fastened and the can is pushed to the farther side of the bench for removal. The

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There are frequent small spillages of leaded gasoline caused by:-

- a) swinging up the swivel tap before it has drained itself into the can;
- b) Overfilling of the can from inattention on the part of the operator;
- c) ill-fitting cap on the can.

These spillages occur on the face and clothing of the operators.

It was difficult to calculate the amount of spillage, but it was estimated at more than one gallon per hour.

Many operators remove their gloves and wash their hands in leaded gasoline at the end of the shifts.

3. AIR-SAMPLING TESTS.

Air samples were taken from points 1 and 17 at each end of the filling bench, and from two points, 5 and 14, nearer the middle of the bench, and in addition from a point (x) further inside the building (see plan).

At each of the filling bench points, air was sampled at two levels, - opposite the can opening, and at face-level.

The results obtained are given in full on the last page, and are summarised as follows:-

Readings at FACE HEIGHT in mgms of Lead per 10 cubic metres.					
Point No. 1	B	6.6	17.8	B	4.3
	y			y	
17		7.4	8.9		3.6
	d			n	
5	a	9.8	8.3	i	5.25
	y				
14		8.8	9.5		2.1

Readings at CAN HEIGHT in mgms of Lead per 10 cubic metres.					
Point No. 1	B	4.1	7.9	B	6.0
	y			y	
17		13.2	19.8		6.0
	d				
5	a	10.1	14.3		5.25
	y				
14		35.5	9.5		5.25

Readings at Point (x) in the Building in mgms of Lead per cubic metres.					
BY DAY		2.5	4.9	7.6	3.6
BY NIGHT		3.6		3.15	

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	d			n	
5	a	9.8	8.3	i	5.25
	y			e	
14		8.8	9.5	n	2.1
				t	

Readings at CAN HEIGHT in mgms of Lead per 10 cubic metres.					
Point No. 1	B	4.1	7.9	B	6.0
	y			y	
17		13.2	19.8		6.0
	d			n	
5	a	10.1	14.3	i	5.25
	y			e	
14		35.5	9.5	h	5.25
				t	

Readings at Point (x) in the Building in mgms of Lead per cubic metres.					
BY DAY		2.5	4.9	7.6	3.6
BY NIGHT		3.6		3.15	

Six separate tests were run, - 4 by day, and 2 by night.

The first and third runs are represented by the day figures

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cans filled per hour was 800 and 650 respectively.

The fourth and sixth runs are represented by the day figures at Points 5 and 14; during these runs the average number of cans filled per hour was 700 and 620 respectively.

The second and fifth runs are represented by the night figures at points 1 and 17, and at points 5 and 14 respectively.

The temperature was recorded at approximately hourly intervals during the tests and the range was as follows :-

DAY -	62°F.	to	78°F.
NIGHT -	60°F.	to	70°F.

4. DISCUSSION AND CONCLUSIONS.

The figures given show that the air of the can-filling building contains more lead than is considered safe for prolonged work. 1.5 mgms. per 10 cubic metres is the figures to be aimed at.

Theoretically, the spillage of one gallon of leaded gasoline would give rise to a lead content of 5 mgms. per 10 cubic metres of air (1 c.c. Ethyl gasoline contains 1.12 mgm. Pb) in this building of 1169 cubic metres capacity; assuming that 8 changes of air occurred per hour. Since it was estimated that more than one gallon was spilt per hour, it follows that spillage is of considerable significance.

Ethyl gasoline of similar lead content, when spilt in a quantity equivalent to two gallons on wood, in a room with door and windows open, gave a figure of 34 mgms. of lead in 10 cubic metres of air at the end of one hour, and $\frac{1}{4}$ th. of the lead was retained in the wood after 8 hours.

(Final Report of Departmental Committee on Ethyl Petrol, 1930. Table XVI, P.50).

In addition to lead in air from spillage, is lead contained in the gasoline vapour which comes from the tin during filling operations. The higher figures obtained at can height would seem to show that this source of lead is also significant, though it may be accounted for partly by evaporation from spillage on the wooden bench. The higher figures at can height obtained by night are probably due to the latter cause.

5. SUGGESTIONS AND RECOMMENDATIONS

1. The wooden bench should be scrapped and replaced by a metal bench with grid top and exhaust ventilation below. In cross section the bench would be V-shaped with a grid across the top of the V. The wooden platform on which the operators stand should be replaced by a metal grid platform.

2. There should be a ventilating hood over the bench, faced with glass, or some other transparent material and coming below face-level, with exhaust ventilation which might connect with that

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X 4

3. The possibility of a cap on the swivel tap, which would fit loosely over the mouth of the can and which would have exhaust ventilation to take away the gasoline vapour into a duct, might be considered. This would require to be made from transparent material, since the filling is visual.
4. Greater supervision should be exercised in order to cut down spillage to a minimum: automatic filling might be considered.
5. Floor should be tiled for width of at least one yard round the filling bench, and floor washing with plenty of water at end of each shift daily would help to keep the air sweeter.
6. Disallow washing of the hands in leaded gasoline and provide alternative washing facilities, if such do not already exist.
7. Provision of bib and apron to be worn by operators, to prevent contamination of clothes, would be of some slight value.

6 ACKNOWLEDGMENTS:

We wish to acknowledge with thanks the willing help afforded by Mr. Smith and his colleagues at the Refinery and the hospitality extended, especially to one of us (H.P.), who was responsible for carrying out the actual tests.

(SIGNED) R. FOSTLES
D. A. K. CASSELLS.

No. of Run	1.	3.	Average of 1 & 3	2.	
Date.	26.7.43	27.7.43			
<u>SAMPLING PERIOD</u>					
Start	11.35 h.	07.40		22.45	
Finish	21-40	16-05		05-45	
Time in Hand	10h.5 min.	8h.25 m.		7 h.	
No. of Cans Filled	8061	5490		-	
Avg. No. of Cans filled per hour.	800	650		-	
Temp. °F. during period of Sampling.	70 to 72	64 to 72		70 to 61	
<u>SAMPLE POINTS</u>					
No.1 Can Filling (2" to the Right &) (5" above No.1) (Can Filling Point)	(Mgm.Pb.per 10 cubic metres) 4.1	7.9	6.0	6.0	No.1 Can Filling (1" to the (5" above (Filling Point)
No.2 Face High) (8" in front and) (16" above No.1) (Can Filling Point	6.6	17.8	12.2	4.8	No.2 Face High (8" in front (above No.1 (Filling Point
No.3 Can Filling (2" to the Right and) (4" above No.17 Can) (Filling Point)	13.2	19.8	16.5	6.0	No.3 Can Filling (1" to the (4" above (Filling Point)
No.4 Face High (6" in front and 16") (above No.17 Can) (Filling Point)	7.4	8.9	8.1	3.6	No.4 Face High (8" in front (above No.17 (Filling Point)
No.5 (Eight Yards in Building) (in line and from No.18) (Can Filling Point)	2.5	4.9	3.7	3.6	

	4.	6.	Average of 4 & 6.	5	Average of 1,3,4 & 6 (DAY)	Average of 2 & 5 (NIGHT)
	28.7.43	29.7.43		28.7.43		
	11-20 18-10 6h.50 m.	07-40 15-35 7h.55 m.		22-45 06-45 8 hrs		
	4912	4951		-		
	720	625		-		
	70 to 78	62 to 72		68 to 60		
<u>SAMPLING POINTS</u>						
1 Can Filling (1" to the Right and) (5" above No. 5 Can) (Filling Point)	(Mgm. Pb.per 10 cubic Metres). 10.1	14.3	12.2	5.2	9.1	5.6
Face High (8" in front and 12") (above No.5 Can) (Filling Point)	8.8	8.3	8.5	5.2	10.4	5.0
3 Can Filling (1" to the Right &) (4" above No.14 Can) (Filling Point)	35.3	9.5	22.4	5.2	19.4	5.6
Face High (8" in front and 12") (above No.14 Can) (Filling Point)	8.8	9.5	9.1	2.1	8.6	2.8
	7.6	3.6	5.6	3.1	4.6	3.4

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OUR REF. O/af

YOUR REF.

29th July, 1943.

Dr. Robert A. Kehoe,
College of Medicine,
University of Cincinnati, Ohio,
U.S.A.

Dear Bob,

We have recently received reports from the Middle East and Persian Gulf areas of a number of cases of sickness amongst men filling gasoline cans. Of the reported cases eight have died - seven in one place and one in the other. The medical evidence available is not, as yet, sufficient to establish the exact cause of death, but I am attaching hereto copy of a report from one of the areas concerned which I think you will find of interest.

The trouble has occurred in can filling sheds around which protective blast walls have been erected, resulting in inadequate ventilation. To date, the reported trouble has been restricted to two can filling sheds, both handling 100 Octane gasoline with a lead concentration of 4 c.c.s per U.S. gallon. The facts at present available indicate that in both cases ventilation was extremely poor, and that as a result of immediate steps taken to improve it there has been no recurrence of the trouble.

The figures you will see quoted in the attached report, for the lead concentration in the atmosphere are, I think you will admit, somewhat alarming; both before and after the ventilation had been improved. These figures, however, should not be taken too seriously since their accuracy is suspect. For the immediate moment the important thing is, whatever might be the cause of the trouble, the answer is: improved ventilation - which is exactly what one would expect.

We recently had a meeting at this Office of representatives of the Companies concerned, which was attended by both Dr. Cassells and Professor Dodds. We were fortunate in having present two members of the staff of one of the Refineries concerned, who were able to give us first-hand information of the exact conditions, details of which I will not burden you with at the present time.

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We have asked for further information which may, or may not, be forthcoming since the bulk of the labour concerned is casual; and it is extremely difficult to obtain any exact case records. However, from one area it is expected we shall receive some further data.

Cassells is carrying out tests for lead in the atmosphere, at similar type can filling installations in this country; but as you will appreciate, the temperature conditions here are quite different.

We have sent out to the areas concerned a detailed memorandum on our standard method for determining small quantities of lead in the atmosphere, and we are also having made up a number of air samplers for sending out to these points.

Dodds has prepared for us a memorandum on the method of analysing for lead in urine, and this we have also sent out. Since it is improbable that we shall be able to rely on accurate urine analysis, we have requested that, if transportation permits, they send us samples of urine collected in the manner laid down in Dodds' memorandum.

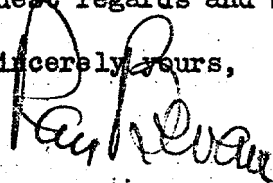
The Companies concerned have warned all their other can filling depots - of which there are many - that the ventilation of these Plants must be carefully examined, and if blast walls are erected then forced ventilation must be installed.

I know this is a matter in which you will be very deeply interested and you may consider it advisable to warn American oil companies and also U.S. Forces, both of whom are in all probability operating similar types of can filling Plants under all kinds of queer conditions. In this connection I would point out that the conditions which have brought about this trouble have arisen solely due to the necessities of war, and I am afraid no one paid sufficient attention to the differences between the war- and peacetime operation of these Plants.

I am preparing a complete dossier on the subject which I will, in due course, send to you. In the meanwhile, I hope the information contained in this letter will be of interest and I would welcome any comments or advice you may be able to give us.

With kindest regards and best wishes,

Sincerely yours,



T. R. A. BEVAN.

Original and enclosure
by airmail: Copy by
steamer.

KE 0007183

It will be appreciated, therefore, that everything - climatic conditions, decrease in ventilation, and pressure of work - combined to bring about this unfortunate state of affairs.

In all, 51 persons were examined and 50 were found to be excreting lead in the urine in more than the generally accepted "normal" amount i.e. more than 0.14 mgms per litre of urine. Of the 50 persons affected, 31 were suffering from symptoms, and an analysis is given of the prominent symptoms displayed:-

Mania	.....	2
Weakness	.....	17
Fever	.....	6
Muscular Pains	.....	2
Diarrhoea	.....	1
Malaria	.....	2 (0.42 mgms. & 0.55 mgms per litre)
Pneumonia	.....	1 (0.35 mgms. per litre).

TOTAL 51

It is to be regretted that at the time we were working short-handed, and as a result there are many investigations which we would like to have carried out, for which the time was just not available so that only four cases were examined for Punctate Eosophilin, and all the examinations were negative.

Apart from the two cases of Mania (Encephalopathy) no signs of any significance were found on examination of the Central Nervous System, and in no case was a "lead line" found on examination of the mouth.

We find it noteworthy that all the cases who were admitted suffering from a high fever showed a fairly high lead excretion, a point which we have not seen mentioned in any of the publications we have read on the subject. During one of our visits to the F.O.D., we were asked to look at several cases of desquamation of the feet in workers in the F.O.D. At the time we were not aware of the fact that this is a sign of T.E.L poisoning and we were equally certain that they had none of the appearances of Paraffin Dermatitis. There is no doubt in our mind now, however, that these men were suffering from the effects of T.E.L.

With regard to the distribution of affected and non-affected persons according to their actual employment, the following is an analysis:-

	More than 0.14 mgms lead in urine.	Less than 0.14 mgms in urine.
Filling Section	25	9
Soldering Section	5	4
Cleaning Drums with Petrol(?)	5	
General Duties (Office)	1 (0.15 mgms.)	2
NO history obtained	2	

TOTAL 51

KE 0007184

Mania	.....	2
Weakness	.....	14
Fever	.....	6
Muscular Pains	.....	2
Diarrhoea	.....	1
Malaria		2 (0.42 mgms. & 0.55 mgms per litre)
Pneumonia		1 (0.55 mgms. per litre).

<u>TOTAL</u>	<u>31</u>
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	<u>More than 0.14 mgms lead in uring.</u>	<u>Less than 0.14 mgms in urine.</u>
Filling Section	25	9
Soldering Section	8	4
Cleaning Bruses with Petrol(!)	3	
General Duties (Office)	1 (0.15 mgms.)	2
No history obtained	2	
<u>TOTAL</u>	<u>39</u>	<u>15</u>

As one would expect there is a definite preponderance of cases from the Filling Section which show a high excretion of lead in the urine. The workers who were filling petrol into tins, for purposes of cleaning, are interesting as they must have been using leaded spirit for the purpose. The one office worker in the "abnormal" list can, I think, be ignored as his lead excretion is hardly to be regarded as abnormal.

The amount of lead in the atmosphere of the Filling Section at the F.O.D was examined by our Chemical Department, and the following is an abstract from their conclusions:-

1. Published data indicate that freedom from ill effects may be expected if the lead in the atmosphere is kept below 2 mg. of lead per working day equivalent to 4.6 cu.m. of air in 8 hours.

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2. Before the blast walls in the P.O.D were pulled down, the atmosphere at head height over the tinning 100 O.N. spirit (containing 4.7 c.cs T.E.L per gallon) under summer conditions, contained 13-20 mg. lead per 4.6 cu.m. of air.
3. Under approximately the same conditions but after removing the blast walls the lead content averaged circa 7 mg. per 4.6 cu.m of air.

This figure is still too high, but since then the system of suction ventilation referred to above has been instituted and is working satisfactorily. The amount of lead in the atmosphere at the Filling Section will be estimated again in the summer when conditions are comparable, and we confidently expect to find that the figure will be well inside normal limits.

As regards the Soldering Section, the amount of lead in the atmosphere was satisfactory, being circa 1.7 mg. lead per 4.6 cu.m. of air, at 1 1/2 ft. above the surface of the molten solder.

It will be appreciated from the above facts and figures that the handling of "loaded" spirits under certain extreme conditions can constitute a very grave hazard, a hazard which, though unlikely to occur under normal peacetime working conditions is very liable to occur under the stresses of War Production.

At the same time, however, we are quite satisfied that all that is required to make conditions entirely safe for workmen is an adequate system of ventilation, plus a keen watch on all possible areas where "spillage" is likely to occur. Since the blast walls at the Filling Section were removed, washing facilities improved and the European personnel of the P.O.D made aware of the risks, there have been no further cases of lead poisoning reported from this Refinery.

3. Better washing facilities be provided for workmen along with liquid soap and sufficient quantity, and increased W.C. facilities.

4. Provision for regular treatment of clothes by automatic cleaners.

The figures of admission to hospital are of interest.

led to trial because of symptoms

<u>1943</u>	
July	.....
August	.....
September	.....
October	.....
November	.....
December	.....
	1
	5
	23
	9
	6
	1

It should be noted that the blast walls were built in May 1943, and that they were taken down in September 1943.

The working month at the P.O.B consists of 30 shifts. The No. of shifts filling loaded spirit in 1941 as compared with 1943 is given in the table below as well as the maximum and minimum temperatures for these years.

1941

1943

No. of Shifts
(Loaded
Spills)

Mean monthly
Temperatures
Max. Min. (°F)

No. of Shifts
(Loaded
Spills)

Mean monthly
Temperatures
Max. Min.

17

112.2°

42.8

70

110.8

LEAD POISONING.

PRELIMINARY MEDICAL REPORT OF CASES OCCURRING IN ABADAN.

In July and August of 1942, there occurred six cases of lead poisoning amongst workers in the Packed Oil Department all of whom displayed symptoms of Encephalopathy. Unfortunately the first case died of anaemia which had developed before admission to Hospital and although we are morally certain that it was a case of lead poisoning, we were never able to prove the fact.

The finding of lead in abnormal quantities in the urine of the other five cases led to a visit to the P.O.D by the Chief Medical Officer and the Pathologist, who found that exigencies of the present War had led to a vast increase in the output of "leaded spirit". A blast wall had been built around the Filling Section which made ventilation very unsatisfactory, and the rapid evaporation of the spirit at the very high temperatures which obtain in Abadan in the summer meant that the air was full of T.E.L vapour, a fact which was later proved beyond any doubt.

The C.M.O and the Pathologist made certain recommendations which were immediately put into force with the result that there was an immediate improvement in the figures of admission to Hospital of cases suffering from lead poisoning.

These recommendations were:-

1. Powerful forced ventilation should be provided at all the "danger points".
- 2.

able to prove the fact.

The finding of lead in abnormal quantities in the urine of the other five cases led to a visit to the P.O.B by the Chief Medical Officer and the Pathologist, who found that the excretion of the present War had led to a vast increase in the output of "leaded spirits". A blast wall had been built around the Filling Section which made ventilation very unsatisfactory, and the rapid evaporation of the spirit at the very high temperatures which obtain in Abadan in the summer meant that the air was full of T.M.L. vapour, a fact which was later proved beyond any doubt.

The C.M.O and the Pathologist made certain recommendations which were immediately put into force with the result that there was an immediate improvement in the figures of admission to Hospital of cases suffering from lead poisoning.

These recommendations were:-

1. Powerful forced ventilation should be provided at all the "danger points".
2. The blast walls should be pulled down at once.
3. Better washing facilities be provided for workmen along with liquid soap in sufficient quantity, and increased W.C. facilities.
4. Provision for regular treatment of clothes by automatic cleaners.

The figures of admission to hospital are of interest.

Cases admitted to hospital because of symptoms

1943

July	.....	1
August	.....	3
September	.....	23
October	.....	9
November	.....	6
December	.....	1

It should be noted that the blast walls were built in May 1943, and that they were taken down in September 1943.

The working month at the P.O.D. consists of 90 shifts. The No. of shifts filling loaded spirit in 1941 as compared with 1942 is given in the table below as well as the mean maximum and minimum temperatures for those years.

1941

1942

	No. of Shift (Loaded Shifts)	Mean Monthly Temperatures		No. of Shift (Loaded Shifts)	Mean Monthly Temperatures	
		Max.	Min. (°F)		Max.	Min.
July	17	112.2°	82.8	70	110	83
August	11	111.5°	79.3	36	114	81.8
September	26	108.6°	73.4	66	106	73.8
October	27	94.4°	62.8	89	97	69.3
November	36	85.0°	55.9	41	83	59.2

KE 0007188

ETHYL CORPORATION

INTER-OFFICE CORRESPONDENCE

TO Dr. R. A. Kehoe ADDRESS Cincinnati

FROM Mr. J. C. Gonzalez ADDRESS New York

SUBJECT DATE August 3, 1943

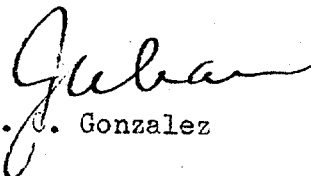
Personal and Confidential

Dear Bob:

The enclosed confidential message from Bevan is passed along to you for your information in accordance with the request in the last paragraph.

You will note that Ray has asked the Petroleum Division in London to bring this matter to the attention of O.B.P.R. in Washington. We have mentioned storage informally from time to time to O.B.P.R. but apparently the urgency in getting the material to the destinations involved has out-weighed the storage problem. At least this seems to be the situation as nearly as we can gather. We have not taken the question up with the Navy Department who actually purchase the goods.

No doubt you will wish to clear the subject through the channels that you have established before we attempt to do anything further directly with the Navy Department in Washington. We will await your comments.


J. C. Gonzalez

O:ha
Enc.

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