ACROPOLE PALACE HOTEL
S. A. E. H.
ATHÈNES - GRÈCE

TÉLÈGR.: ACROPALACE
TÉLÉPH.: 53.851-2-3

Canea April 17-39

My dear Mr Weight:

Upon my last conference with Mr George Naxakis he extolled to me the wonderful work of the Rockefeller Foundation and your beneficial services and achievements in the Near East, as its representative. He also informed me of your intended visit to Greece during this Spring, and in view of that I am taking this opportunity to address this letter to you.

As a member of the office of the General Counsel of the Treasury Department at Washington, I am taking my vacation in my homeland, the island of Crete, and I am intending to leave Athens round May 20th to return to Washington and my duties.

However, as Legal Counsel of the Pancretan Association, interested in expediting the preliminary work for the erection of a Tuberculosis Sanitarium in Crete, the necessary funds already collected from the Cretans residing in the United States, I feel that I should not miss an opportunity of a personal contact with you and so take advantage of the vast and valuable experience gained by you in the Near East as a representative of the Rockefeller Foundation.

I shall consider therefore myself very fortunate and honored by your personal acquaintance and as I am intending to take short trips to Constantinople and Egypt, in the near future, I beg of you to kindly inform me of the approximate time of your intended trip to Greece, by addressing a letter to me, at Kaniggos street # 36, Athens Greece, so that by arranging my intended trips I may be able to meet you in Athens or elsewhere at your convenience during your visit to Greece this Spring.

Sincerely yours

Louis E. Callis

Copy for Mr. Wright

July 22, 1940

Air Mail

Through Dr. Warren

Dear Dr. Or:

I am going to drop you a short note with the hope that it will reach you without undue delay.

We were able after quite a delay in Greece to catch one of the Expert Line boats for America, and it was not much fun feeling our way through the mine fields from Pireaus to Lisbon, but by good fortune we made the trip safely. We were out of Naples the night before it was bombed, and cleared Gibralter the night before it received a thorough bombing, so you see we were in luck.

We found on arriving in New York that about the entire European staff of the Foundation had preceded us and, as it turned out, the boat we came on was our last chance for the present at least.

There is quite a little uneasiness in the United States over the final outcome of the struggle now going on in the Old World, but there is strong hope that we as a country will not be drawn in before the final curtain is drawn, and of course it will depend very largely on what the final demands of Germany are if she succeeds in crushing England. If there is an attempt to extend domination to this side of the water, I do not think there is any doubt but what she will meet with the full and whole-hearted resistance of this part of the world, but if she confines her domination to the other side, we will to a large extent at least keep hands off.

We are all sincerely hoping that Turkey can manage to keep out of actual conflict and retain her national sovereignty.

My thoughts drift back to you and your work, and it is my hope that conditions will make it possible for me to get back with you this fall. I feel sure that, in the end, in spite of discouragement, you are going to be able to get over a real program, one of which you and the country will be proud. I am in hopes that you are getting along well with the demonstration work which you have under way and that you will keep me posted on progress.

Dr. Collins has had his operation, and is getting along nicely, but will be required to stay in bed until about the first of September. He was very anxious to have a report of what was taking place in Turkey and your work in particular. So far as he can plan now, he will not go to his new post until after the first of next year.

I have received no word from Turkey since leaving there and, in fact, letters which I posted before leaving have not yet arrived. The tie-up must be very complete.

Am leaving New York for Virginia the first of the week, but any mail addressed to me care of the Foundation will reach me.

Give my regards to your family and any friends you may see.

As ever your sincere friend,

D. E. WRIGHT

Dr. Cemal Or
Sanitation Center
Etimesut, Ankara
Turkey

DEW:JL

Copy for Mr. Wright

July 22, 1940

Air Mail

Through Dr. Warren:

Dear Dr. Mahmut:

After many delays we arrived in New York without serious mishap and, while I regretted very much its being necessary for me to leave Turkey, I am very glad that the trip is behind me.

We over here are hoping that Turkey will be able to keep out of a serious conflict, as at best it could only result in retarding the great progress that has been made and planned for the future.

The office has assured me that, if conditions permit, I will be returned to my work and the program in which I am so thoroughly interested.

May I extend to you and other friends in the school the sincere appreciation of Mrs. Wright and myself for the remembrance which was given us by friends in the school on our departure.

Kindly remember me to all as if named, and be assured that I will always have a warm place in my heart for Turkey as a country and the many warm friends I have there.

Yours sincerely,

D. E. WRIGHT

Dr. Mahmut S. Akalin
Director of the School of Hygiene
Ankara, Turkey

Copy for Mr. Wright

July 22, 1940

Air Mail
Through Dr. Warren

Dear Dr. Saim:

You will no doubt be glad to know that after considerable delay we reached New York safely and, while I was very glad to be home again, I regretted very much its being necessary to leave my work in Turkey and the many friends there.

The entire situation in the Near East has been discussed with Dr. Warren, and it is his hope that it will not be long before the activities of the Foundation in that part of the world can again be resumed.

I had a talk in the office a few days ago with the young man whose fellowship we discussed before my leaving Ankara, and I explained to him that you would have been quite willing to approve a fellowship for him had he complied with the necessary regulations.

Dr. Collins, as you no doubt know, has been operated on for the injury to his back and, while he is getting along nicely, he will be confined to his bed until about the first of September. I had a talk with him and he requested me to send his kindest regards to you and your wife.

We are all hoping over here that Turkey is going to be able to keep out of war and at the same time maintain her freedom and territory.

It is my present plan to take such leave as I have due and, if conditions permit, return to the Near East for work.

The two Turkish fellows at present in the United States are doing very well but under existing conditions no one feels quite certain as to just how they will be able to get back to Turkey this fall.

With kindest regards to Mrs. Saim and best wishes for you, I am,

Yours sincerely,

D. E. WRIGHT

Dr. Saim Srar
Executive Secretary
Ministry of Hygiene
Ankara, Turkey

DEW:JL

THE ROCKEFELLER FOUNDATION

INTERNATIONAL HEALTH DIVISION

49 WEST 49th STREET, NEW YORK
CABLE ADDRESS: ROCKFOUND, NEW YORK

July 22, 1940

No. 9

Dear Mr. Wright:

The following letters have been received:

June 3 — Enclosing statement of activities from January - June 1, 1940, and current monthly account.

July 19 — Enclosing semi-annual report for period January 1 - July 1, 1940 for sanitary engineering for Turkey, Greece and Bulgaria, and report of activities for June.

Sincerely yours,

Helen R. Vroom

Secretary

Mr. D. E. Wright
49 West 49th Street
New York City

anyone [illegible] foreign affairs which Kemal Ataturk [illegible] at the opening of the Turkish [illegible] Assembly last Monday could [illegible] imagine that the speaker was not only [illegible] but in some respects the [illegible] powerful of them all. In his [illegible] he challenged no [illegible] of anybody, referred to the [illegible] of the Balkan Pact and the [illegible] pact with Afghanistan, Iran and Iraq and declared that Turkey would continue to respond to every appeal for peace.

The speech was typical of the man— quiet, unassuming, and yet revealing a sense of strength which has not only earned him the affection of the 15,000,000 Turks whom he has ruled for fifteen years, but the respect and esteem of statesmen who have succeeded each other on the world stage during this period. He is a dictator and a leader, but the builder of the new Turkey [illegible] who infused its [illegible] that [illegible] corpse [illegible] who changed the [illegible] and outlook of a people steeped in the ignorance and prejudices of centuries of obscurantism and oppression, rendered it secure from the predatory intrusions of Western European nations, and gave it the pride and dignity of a first-rank modern nation.

The physical transformation of Turkey under Kemal Ataturk has been in line with the social and political miracle which he has wrought among his people. All who knew the country before the war, with its squalor, disease and poverty, speak of the change as a marvel which has no parallel in any other country in modern times. There are roads where formerly there were paths or nothing at all, towns where there were collections of hovels undeserving the name of villages, and post and telegraph offices, schools, public baths, children's playgrounds, clinics and hospitals everywhere.

It must be admitted there is nothing dictatorial, in the popularly accepted sense, in what Kemal Ataturk has done for his people. He himself [illegible] dislikes being called a dictator, though, in the early years of his rule at least, he was as ruthless a dictator as any that have appeared so far. He was worse, perhaps, for he [illegible] who conspired against him [illegible] suppressed without the least [illegible] all who dared to oppose or even criticize his reforms. He went straight ahead with the constructive task he had set himself to erase the last vestige of the so-called Ottoman Empire of the Sultans, confident that when the task was finished he would earn the gratitude of his people.

That has actually happened. To the Turks, the Ataturk is no dictator, but a father. To the world, he is a great leader, whom any democratic [illegible] might envy. The liberty he [illegible] in his country was the freedom of [illegible] ruling class to keep the people in ignorance and to fatten on the earnest

<u>SUPPRESSIVE TREATMENT OF MALARIA.</u>

(By Assistant Director of Hygiene (Anti-malaria) General Headquarters).

1. Suppressive treatment is advised with a view to reducing the occurrence of clinical attacks of malaria.

2. It does not prevent malarial infections. On the cessation of treatment, therefore, a large proportion of those infected will go down with attacks of malaria.

3. The extent to which malaria is suppressed as the result of treatment varies with the following factors:-

(a) The virulence of the local strain of malaria parasite;
(b) The state of immunity of the individuals receiving treatment;
(c) The numerical dose of sporozoites per infected mosquito bite, which is high when
   (i) malaria transmission season is at its height,
   (ii) an epidemic form of malaria is prevailing in the area.

4. Since it is difficult to assess accurately the influence of these factors singly or jointly, it is not always possible to foretell the degree of success which will attend suppressive treatment. It is essential therefore to be on guard against a sense of false security.

5. Apart from the factors mentioned in para. 3, the effectiveness of suppressive treatment is directly dependent upon the zeal and vigour with which the measure is enforced.

6. To ensure that every individual receives the prescribed dose regularly, suppressive treatment should be organised in an Infantry Battalion or equivalent unit on a company basis.

7. The drug should be administered in the presence of company commanders or company officers. Special arrangements will be necessary for detachments and for men on guard duty.

8. The dosage and drugs employed will be as follows:-

(a) Five grains of quinine hydrochloride or sulphate in tablets daily. This may be increased to ten grains daily, if the former dose proves inadequate to control an outbreak.

or (b) Atebrin 0.2 grains a day on two consecutive days in a week.

9. The treatment must be commenced not later than the fourth day of the entry of troops into an infected area. It should be continued for at least a fortnight after the end of the malaria season or the return of troops to a locality where malaria is absent or has been brought under control by anti-malarial measures.

10. To avoid the sudden rush of malaria cases, the suppressive treatment should be withdrawn gradually e.g. from one company of a battalion at a time. In this connection due consideration should be given to factors mentioned in para. 3.

11. Suppressive treatment should in no circumstances be utilized as a substitute for the usual protective measure against malaria. Its use should as a rule, be restricted to occasions when no other anti-malarial methods are feasible.

MDMS—N 4 (N)
20,000

PREVENTION OF MALARIA ON FIELD SERVICE.

1. Adequate protection against malaria is of a vital importance in the prosecution of war in Eastern countries.

2. Many protective measures employed in cantonments are *not* feasible on field service. It is necessary therefore to cultivate the requisite change in outlook.

3. From practical experience in this war, the following precautions have been found to be invariably successful when carried out in full:—

(*a*) Avoid local villages. Allow at least ½ mile and preferably ¾ mile between the villages and the periphery of your camp.

(*b*) If the tactical situation does not permit of compliance with this rule, spray all the village houses with "flit" morning and evening.

(*i*) Spray the village whether occupied or deserted.

(*ii*) Employ young local boys if occupied. Employ unit personnel if deserted.

(*c*) Spray your tents, huts or barracks with "flit" daily. Detail for this purpose one man per tent; or form a company squad to carry out systematic spraying operations. See that such squads are properly instructed in the method of spraying by your unit medical officers.

(*d*) See that all ranks possess and use mosquito nets. Give frequent instructions in the proper use of mosquito nets. Institute special drives to apprehend defaulters.

(*e*) Enforce the wearing of long sleeves, long trousers or turned-down shorts after dusk. Employ every possible means to secure strict adherence to this order.

(*f*) For as long as men are exposed to mosquito bites, *i.e.*, when not inside a mosquito net every individual must apply anti-mosquito cream hourly or every two hours.

4. Methods of spraying are fully described in the pamphlet "Anti-malaria measures in Military Stations in India", a copy of which has been supplied to every medical officer in India.

5. Protection against malaria will be secured only if *all* these instructions are meticulously carried out in every detail.

6. Protective measures must be enforced un-interruptedly throughout the malaria season. Exposure to infection for *one night* in the present war once brought down 25 per cent. of a certain battalion with malaria.

W. H. G. BAKER,
Lieut.-General,
Adjutant General in India.

General Headquarters, India,
New Delhi.

GIPD—38—1274 Army—18-4-42—20,000.

PRACTICAL FIELD APPLICATION OF DDT FOR MALARIA CONTROL+

I. GENERAL

Pure DDT is a white crystalline substance that was first synthesized by a German chemist in 1874. DDT is a convenient abbreviation for Dichloro-Diphenyl - Trichloroethane, or more correctly written 2, 2, - bis (parachloro-phenyl) 1, 1, 1 - trichlorethane. It has been referred to by the trade names of "Gesarol", "Neocide", and as SELY. Its insecticidal properties were not discovered until 1939, when a Swiss chemical firm (J. R. Geigy, Inc.) began to use it in the control of clothes moths and plant lice. The fact that this amazing insecticide was overlooked for 65 years is probably due to its slow lethal action and peculiarphysiological effects on insects. When a DDT solution is sprayed on a wall, the crystals are left evenly distributed after the liquid has evaporated. Mosquitoes or other insects brush against or crawl over the crystals. After they have been in contact with DDT particles for several minutes, some of it is absorbed through the tips of the tarsi or other parts of the body. This creates a powerful action on their nervous system; they become restless and attempt to escape; their movements become poorly co-ordinated and they finally develop tremors and convulsions and die from 1 to 48 hours after touching a DDT treated surface. Mortality is determined primarily by the period of contact and the rate of absorbtion through the insect's feet.

As an insecticide, DDT is a new and revolutionary discovery. Its use as a residual spray is a new approach to mosquito control. The major purpose of using DDT in a residual spray is to form a deposit that will kill insects

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+ Prepared by Gordon E. Smith, San. (R)
United States Public Health Service

which crawl over the treated surfaces after it is applied. The main advantages of DDT over previously used insecticides are that: (1)

(1) Very small quantities, well dispersed, will give good results.

(2) Its prolonged residual effects will kill adult mosquitoes a long period of time after its application to their nocturnal and diurnal resting places.

(3) It is relatively easy to prepare and apply and is only slightly toxic to man.

(4) It has a wide range of application as a dust, an oil solution, a water emulsion, or as a thermal aerosol when applied by hand, power sprayers, or airplanes, according to the circumstances. The best preparation and method of application will vary according to the species for which control is desired, on field conditions, the magnitude of the problem, and the materials and equipment available.

In all field tests DDT is proving to be the best insecticide that has ever been used. To be effective, however, it must be applied carefully to the proper places according to recommended procedures by field workers or supervisors who have a thorough biological knowledge and understanding of the insect species for which control is desired. A little DDT efficiently spread is better than a lot spread haphazardly.

The urgent need for instruction in the use of DDT is apparent. This report is intended to serve as a guide and to summarize the information available that will be most useful to health workers in the field who will be required to make practical applications of DDT for mosquito control.

II. MOSQUITO BIOLOGY

For intelligent, economical, and effective malaria control operations, it is extremely important that the habits of the particular mosquito species for which control is desired are carefully studied and understood. The species vary in their biting habits, breeding habits, distribution, and ability to transmit malaria; therefore, a thorough knowledge of mosquito biology is essential before DDT can be applied intelligently to surfaces where it will do the most good. Spraying should be done in places where mosquitoes breed, rest during the day, or acquire their malaria parasites at night.

For a brief example of species variation: In the United States the most common malaria carrying mosquito, Anopheles quatrimaculatus, breeds in still water among the aquatic vegetation in ponds and lakes. The adult females enter houses and bite readily at night. For diurnal shelters or resting places, they enter buildings (houses, barns) at the break of dawn and seek the cool, dark corners, or they may choose the cool, dark, shaded shelters in a wooded area, such as tree holes or hollow logs. Another malaria vector, Anopheles walkeri, breeds in approximately the same type situation, but the habits of the adults are entirely different. They bite readily out in the open at night but they do not like to come inside houses. In an area producing approximately equal numbers of both species, large numbers of adult Anopheles quadrimaculatus may be counted resting in the dark corners of shaded buildings, and no Anopheles walkeri will be seen among them. The adults of Anopheles walkeri may be found in considerable numbers out in tall, dense, sawgrass and other acquatic vegetation resting on the stalks a few inches above the surface of the water and no Anopheles quadrimaculatus will be found in their habitat. By and large, Anopheles barberi breeds only in tree holes and stump water. In Bombay, India, a malaria vector, Anopheles stephensi, breeds in large open wells; in central India the vector, Anopheles culicifacies, breeds in air raid shelters, slit trenches, clear puddles in partially dried-up river beds, wagon ruts, or cow tracks. In Assam and certain parts of Burma and China, the principal vector is Anopheles minimus which breeds in aquatic vegetation along the edge of cool running streams or in cool seepage puddles from mountain sides during the monsoon season. The wild, dense jungle breeder and carrier of malaria, Anopheles leucosphyrus, has peculiarities of its own an differs from all the rest. In Greece, Anopheles elutus the predominent species of coastal swamps, breeds in both brackish and fresh water.

Field workers overseas will not have time to make thousands of mosquito dissections to determine which anophlines are the most dangerous vectors of malaria in a given area, nor will they have time to make complete biological studies. To avoid duplication of efforts, they will be wise to consult the competent local malariologists and entomologists and to make use of all the knowledge that they have accumulated through the years, and to work in close cooperation with the local authorities toward control of the known vectors before starting on a long-term research program involving well known information.

DDT does not act as a repellent to mosquitoes until they touch a treated surface. It should be remembered that after a building has been sprayed with DDT, mosquitoes will not be found resting there in the normal way. The fact that mosquitoes cannot be found by routine inspections does not mean that all mosquitoes in the area have been eliminated. They may continue to come in at night for blood, and if large congregations of mosquitoes used the building as a diurnal shelter before it was sprayed with DDT, the chances are other will continue to come into it in the early morning at the break of dawn, but will leave hurriedly after about five minutes contact with the DDT treated surfaces and will die outside.

For practical applications of DDT to kill mosquitoes, (outside controlled laboratory conditions) the material must either be sprayed on the water surface where they are breeding, or applied as a residual spray to surfaces where the adults will come to rest. To spray buildings or other places not inhabited by resting mosquitoes during the day, nor frequently by those seeking blood at night, or to spray water surfaces not producing larvae, is a waste of time and material.

III. DISPERSING AGENTS

Because of its high toxicity, DDT is always applied in combination with other agents, such as dusts, petroleum oil or other solvents. It is insoluble in water, but water may be used as a diluent when an emulsifier is added to the solvent. A good solvent for DDT is very important. The following table indicates the range of solubilities at normal temperature with some of the most useful solvents.

SOLVENT	SOLUBLE GRAMS OF DDT PER 100 CC OF SOLVENT
Cyclohexanone	100-120
Benzene	77-83
Dichlorobenzene	63-71
Tetrahydronaphtalene	63-71
Polymethylnaphtalenes	
Velsicol AR-40	43
Velsicol AR-50	63
Velsicol AR-60	67
Velsicol NR-70	67
Sovasol 74 or 75	56-62
Xylene	56-62
Acetone	50-55
Benzyl-benzoate	39-41
Dimethylphtalate	31-40
Indalone	29
Ether	27
Triton X-100	20
Tung Oil	14
Sesame Oil	10
Fuel Oil #2	10
Cottonseed Oil	9
Stoddard Solvent	9
Kerosene (Crude)	8
Fuel Oil	8
Kerosene (Refined)	4
Freon (12)	2
Ethyl Alcohol 95%	1.5

Petroleum products such as kerosene, fuel oil, Diesel oil, lubricating oil, or waste crankcase oil will be the only solvent available in many places and will, therefore, be the most practical solvent to use. These solvents are used for making a 5% solution of DDT when pure DDT and no other solvent is available.

Care should be taken not to attempt to mix a higher concentration of

DDT than is indicated in the table above. To obtain a 5% solution in refined kerosene, it is necessary to add a good solvent such as 10% cyclohexanone. Crude kerosene can be used to make a 5% solution, and better solvents such as xylene, Velsicol, or Sovasol are used for making a 35% DDT emulsion concentrate solution.

Polymethylnaphtalenes (Velsicols or Sovasols) have been found to be very good solvents for DDT. Abundant supplies are available in the United States and, for a minimal charge, the producers have indicated a willingness to mix DDT formulations for shipments overseas.

IV. PREPARATION OF MATERIALS

A. USEFUL FORMULATIONS

I. OIL SOLUTIONS

Oil solutions are useful as mosquito larvicides. They are not particularly suitable for residual spraying indoors as they create fire hazards, dry slowly, and spot many surfaces; however, in the C.B.I. war theatre a 5% DDT in crude kerosene was used for all purposes since it was the best solvent available. It was mixed in the field where native manual labor is abundant and the quality of houses poor.

Twenty percent concentrations of DDT in Velsicol NR-70 have been applied very successfully from airplanes equipped with various types of exhaust generators for producing thermal aerosols. Velsicol NR-70 was selected for this use because of its high boiling range, and the desirability of having the solvent persist as long as possible. This solvent itself has been shown to be toxic to mosquitoes. For residual house spraying, the more refined fractions, Velsicol AR-40 or 50, are more desirable.

a. For hand application (larvae control)

(1) 7 oz. DDT + 1 gallon oil = 5% DDT solution.

(2) 2¼ pounds + 5 gallons oil = 5% DDT solution.

(3) 22 pounds DDT + 50 gallons oil = 5% DDT solution.

b. For hand application (Residual spray)

2¼ pounds DDT + 10 gallons refined kerosene = 2½% DDT solution.

c. For airplane distribution

(1) The cub spray unit uses the 5% oil solutions under "a" above.

(b) Aircrafts equipped with thermal aerosol generators use 20% DDT concentrate.

2 pounds DDT + 1 gallon Velsicol NR-70 = 20% DDT concentrate.

II. Water Emulsions

Emulsions form the ideal method for the preparation of DDT. They can be made to accomplish all that oil solutions of DDT can do and they do not possess the objectionable characteristics of oil. They save shipment, or procurement in the field, of large volumes of petroleum oils to be used as solvents or diluents. In this form, DDT can be kept in stock solution for subsequent dilution with fresh or salt water as it is used in the field.

a. For hand or power application for larvae control or as a residual spray for adult mosquitoes.

(1) 4 pounds DDT
1 gallon Xylene+
$\frac{1}{2}$ pint Triton X-100++

35% DDT concentrate

(2) $15\frac{1}{2}$ pounds DDT
4 gallons Xylene+
1 quart Triton X-100+

35% DDT concentrate

(3) 84 pounds DDT
21 gallons Xylene+
$5\frac{1}{4}$ quarts Triton X-100++

35% DDT concentrate

(4) 125 pounds DDT
31.5 gallons Xylene+
2 gallons Triton X-100++

35% DDT concentrate

1 part of the above DDT concentrate + $6\frac{1}{2}$ parts of water = 5% DDT spray solution containing 50 mg. of DDT per CC of spray solution.

1 part + 13 parts of water = $2\frac{1}{2}$% spray solution containing 25 mg. of DDT per CC of spray solution.

b. For aircraft (thermal aerosol) application and other purposes.

44 pounds DDT
22 gallons Velsicol NR-70
$4\frac{1}{2}$ quarts Triton X-100

20% DDT concentrate

The Triton X-100 is not needed in this formula if the solution is to be applied as a thermal aerosol; however, if the emulsifier is added in the field, the solution can be diluted with water and used for other purposes.

\+ Velsicol AR-40 or AR-50; or Sovasol 74 or 75 may be substituted in the above formula for Xylene.

++ Duponol OS may be substituted in the above formula for Triton X-100.

IV. DUST

Pure DDT powder is rather sticky and cannot be diluted in the field for use as a dust, since the heavy grinding equipment necessary for mixing will not be available. The 10% DDT dust that has been sent into the field (primarily for louse control) has been thoroughly ground with a diluent such as pyrophyllite or talc. If it becomes necessary to use some of this material for mosquito control purposes, it may be diluted further to a 1 per cent mixture by the addition of such carriers as fine road dust, soapstone, or condemned flour. (Lime should not be used). For a one (1) per cent mixture, add one part of the 10% dust to 9 parts of diluent. In diluting a 10% DDT (louse powder) for use as a 1% mosquito larvicide, care should be taken to see that the product is thoroughly mixed from 20 to 30 minutes to insure uniform distribution of DDT. For mixing large quantities, a cement mixer, flour mixer or other mechanical equipment is desirable. The diagonal barrel type Paris Green mixer (with a rod through the ends) can be used in the field for small scale operations.

B. MIXING METHODS:

DDT is slowly soluble in kerosene and may require 24 hours with frequent stirring to get it in solution. For this reason and others, it is much more desirable to send DDT into the field as a 20 to 40 per cent concentrate solution, in Velsicol or some other good solvent which can easily be diluted in any manner desired with refined kerosene; or, if an emulsifier is added, with water. This would result in the saving of a considerable amount of shipping space, and would eliminate the necessity of improvising hand mixing devices, or shipping mechanical mixers into the field for this purpose. It, however, it becomes necessary to prepare the DDT solutions in the field, equipment will have to be devised to suit the circumstances.

1. Hand Mixers:

Several types of hand mixers have been used successfully in small operations. If only a small amount is needed, the simplest way to mix it would be to place the mixture in a steel drum and roll it in the sun for 24 hours. A practical and useful device, for routine mixing of small amounts, consists of a 55 gallon barrel mounted horizontally on rockers and provided with handles for rocking. Materials are added through a large bung hole on the upper side of the barrel, and the mixture is agitated by rocking the barrel back and forth. A spigot is added to the bottom of the barrel for emptying. Formula No. 3 above "fits" this type of mixer.

2. Mechanical Mixer:

For mixing DDT and solvents on a large scale, a portable mechanical mixing plant such as the one developed by the Carter Memorial Laboratory should be used. This consists of an upright 55 gallon steel drum and gasoline engine pump assembly mounted in a fixed position on a wooden hand barrow platform. Valves and piping are arranged to permit :

(1) Pumping of a solvent into the mixing drum from a 55 gallon steel solvent drum at ground level,

(2) recirculation of the mixture through the pump for mixing purposes, and

(3) delivery of the mixed concentrate from the mixing drum into 55 gallon drums for storage or shipping. Small containers, such as gasoline or water cans, can be filled with a pet cock at the base of the mixing drum. This power mixer is designed to mix formula No. 4 above.

About 500 pounds of DDT can be mixed per hour with this equipment. The levels for the various ingredients are marked on the drum so that it is not necessary to measure them each time.

V. APPLICATIONS

A. USEFUL EQUIPMENT

At this time we do not have suitable hand equipment that will disperse the small amounts of DDT required per acre (0.1 pound). Because of the minute quantity of DDT required to treat an acre of mosquito breeding surface, the standard malaria control equipment (such as oil knapsack sprayers and pyrethrum spray guns) previously used for applying relatively large amounts of material, is not suitable for the application of DDT. However, it may be necessary, in some theatres of operation, to use this standard malaria control equipment to the best advantage until more desirable equipment, designed especially for DDT, becomes available. New developments in equipment and more effective methods of application are being made from day to day. As this new equipment becomes available, it will take first priority over other supplies for malaria control. Field workers should keep in close contact with all research developments and adopt the methods that suit their requirements as promptly as possible.

Assuming that the men in the field will have adequate transportation and a few other first essentials for malaria control operations, the following items will prove particularly useful in the distribution of DDT.

1. Hand Sprayers

a. The ordinary household "flit" gun, which comes in various sizes and types will be found useful for limited larvicidal operations.

b. The large (2-3 quart capacity) hand pressure sprayer, (Hudson Capital, or equal), is recommended for the routine applications of 5% DDT solutions as a mosquito larvicide. These sprayers combine the advantages of a compressed air sprayer with the efficiency of the continuous type and are especially useful when provided with coarse, medium, and fine nozzles. A model with a release valve, allowing for continuous and uniform spray after the pressure has been obtained, is now being made available in the Navy. It produces a fine spray, ideal for routine larviciding operations and can be used for limited residual spraying.

c. The large, 4 gallon, open head air pressure sprayers are highly recommended for the dispersal of DDT as residual house sprays when provided with the proper nozzles. The Hudson Industrial sprayer has features which make it more desirable than some of the others.

The Army has thousands of Decontamination sprayers in stand-by condition for possible gas decontamination use. If some of these sprayers become available for the control of insects with DDT sprays, they can be used if theu are provided with special nozzles, oil resisting hose, washers and gaskets. These sprayers come provided with two nozzles. One produces a solid stream and the other a coarse spray, both of which are totally unsatisfactory for DDT applications; however, these nozzles have been improved by adding a No. 2½ or 3 orifice plate.

The weak points of the sprayer are in the gaskets, the air check valves and the hose. Replacements for these parts must be kept on hand at all times. Watch particularly the gasket between the pump cylinder and the cover plate. This part wears out most frequently, and needs replacement.

d. The Root Duster (Rotary type) is apparently the most satisfactory for the dissemination of DDT dusts. It produces a fine dust and is a very durable piece of equipment.

2. Nozzles

The most important part of the sprayer is the nozzle. It is very necessary for the successful operation of the sprayers; therefore, it is strongly recommended that an adequate supply of the nozzles listed below be kept on hand. The "proper" nozzles produces a fan spray width of 80°; and when held 18 inches from the wall, gives a swath width of 24 - 30 inches. Such a flat, fan-shaped spray acts like a brush, covering the wall evenly and requiring a minimum of movement on the part of the operator.

a. Nozzle No. ¼T8002 from the Spraying Systems Company of Chicago has been found to be especially desirable; and

b. Nozzle No. ¼031F Mfg. by the Spray Eng. Co., Somerville, Mass. can also be used in this work.

3. Power Sprayers

a. Bean or orchard type.
b. Oil boats.

4. Airplanes

a. The 65 H.P. Piper Cub Aircraft provided with a special spray unit has been used in limited operations.

b. A large 450 H.P. Stearman aircraft equipped with thermal aerosol generators is proving especially good for large scale routine applications of DDT for larvae and adult mosquito control.

c. The Army and Navy have equipped many types of planes for DDT dusting, smoking, and spraying.

d. The 220 H.P. Stearman PT-17 airplane is available and can be equipped with generators for the dispersal of a 20% DDT solution as a thermal aerosol. This is the only type of equipment that has been developed that will adequately disperse the small amounts required per acre.

B. RATE

The amount of DDT applied and the distribution are the important factors in DDT dosages rather than the total amount of mixture. The amount of diluent is important only in that it insures even distribution of the active ingredient. The type of equipment used and area to be treated will determine the type of dilutions to make. For mosquito larvae control, 0.1 pound DDT per acre has given good results when applied in an oil solution, water emulsion, as a thermal aerosol, or as a dust. The dosage will vary from 0.1 to 0.5 pounds per acre according to the type area treated and other field conditions.

TABLE OF DOSAGE

1. For Larvae Control

Formulations	Rates of Application: Amt.	%DDT	Will Treat	Lbs. DDT per Acre	Remarks
DDT+Oil Solutions or DDT+Water Emulsions	1 qt.	5	1 acre	0.1	Good initial kill - Retreat after one week
	5 qts.	1	1 acre	0.1	Good initial kill - Retreat after one week
	2 qts.	5	1 acre	0.2	Army dosage - Good for 2 weeks
	2 qts.	10	1 acre	0.4	Army dosage - Good for 2 weeks
	5 qts.	5	1 acre	0.5	Very toxic to all aquatic life.
	25 qts.	1	1 acre	0.5	Very toxic to all aquatic life.
	10 qts.	5	1 acre	1.0	Very toxic to all aquatic life.
	1 stroke	5	1 sq.yd.	0.5(?)	Hand Sprayer
	2 qts.	2.5	1 acre	0.1	Oil Boat -(Solution mechanically mixed with water for distribution)
	27 gals.	5	50 acres	0.2	Cub aircraft - Army dosage.
	1 ton	100	1 sq.mi. or 640 acre	3.12	Per Year -(Aircraft Distribution) 10-20 applications at rate of 0.1 to 0.3 pounds per acre.
	5 cc.	35	1 acre	0.1	
Thermal Aerosol (Aircraft)	$2\frac{1}{2}$ pts.	20	1 acre	0.5	
DDT+ Velsicol NR-70	$\frac{1}{2}$ pt.	20	1 acre	0.1	Applied at a rate from 0.1 to 0.5 lb. per acre according to the type area treated and field conditions.
DDT + Dust	10 lb.	1	1 acre	0.1	Good initial kill - Retreat after one week.
	10 lb.	5	1 acre	0.5	Good initial kill - Retreat after one week.
	10 lb.	10	1 acre	1.0	Kills for 3 - 5 weeks - Very toxic to all aquatic life.

TABLE OF DOSAGE

2. For Adult Control (Residual Spray)

Formulations	Rate of Application				Remarks
	Amt.	% DDT	Will Treat	Mg. DDT Per Sq. Ft.	
DDT + Refined Kerosene	1 c.c.	5	1 sq.ft.	50	The recommended rate is from 100 mg. to 200 mg. DDT per sq. ft. Higher doses do not give better results. 100 mg. per sq. ft. applied to walls and ceilings, Effective 3 - 5 months.
	1 c.c.	2.5	1 sq.ft.	25	
or	4 c.c.	5	1 sq.ft.	200	
DDT + Water Emulsion	2 c.c.	5	1 sq.ft.	100	
	8 c.c.	2.5	1 sq.ft.	200	
	4 c.c.	2.5	1 sq.ft.	100	
	1 qt.	5	250 sq.ft.	200	
	1 qt.	5	500 sq.ft.	100	
	1 qt.	10	1000 sq. ft.	100	
	1 qt.	2.5	125 sq. ft.	200	
	1 qt.	2.5	250 sq. ft.	100	
	1 gal.	5	1000 sq. ft.	200	
	3 pts.	25	1 house	200	(Average size)
	1½ "	25	1 house	100	" "
	0.2 gal.	2.5	190 sq. ft.	100	Nozzle # ¼T8002 discharge rate per minute at 40 pounds pressure. Operators should practice spraying 190 sq.ft. per minute using less that 1 qt. of spray solution. In practical applications the operators will spray until the wall is "wet" but not to excess run off.
	0.8 lb.	100	1 house	200	
	0.4 lb.	100	1 house	100	
Thermal Aerosol (Aircraft) DDT + Velsicol NR-70	2½ pts.	20	1 acre	0.5 lb. per acre	Kills adult mosquitoes in diurnal shelters. Residual DDT deposits persist on vegetation and kills the adult insects that touch the crystals.

C. METHODS

1. Hand Spraying (for larvae control)

(a) Due to the small volume of DDT solution required for insecticidal action, the small hand sprayers have "come into their own", and are proving very useful. However, sprayers designed especially for DDT distribution with freedom from weight and bulkiness, suitable for dispersing the small quantities required per acre, have yet to be developed. One of the "best" methods of hand application of a 5% spray for routine mosquito larvicide seems to be the small (2 - 3 qt. capacity) air pressure type of hand "flit" gun.

In many circumstances, especially for small scale operations, when mosquito breeding is "spotty" or in isolated places, it will be highly desirable to have the mosquito inspector take along a small hand sprayer (as well as his dipper) and treat the specific spots where mosquito breeding is found. This method of treatment will be both economical and efficient. This, like residual spraying, will be a new approach to mosquito control. In the past, mosquito inspectors would "dip" an area and then "report" the location of mosquito breeding. Then the areas would be treated by oil or dusting crews who carried cumbersome equipment and probably treated some spots not producing mosquitoes and missed others that had been reported.

For routine larvicidal applications, it is suggested that DDT be carried to the field as a 35% DDT emulsion concentrate and diluted with water to make the recommended 5% spray solution as it is needed. This results in considerable saving in transportation. If this emulsion concentrate is carried to the field in drums provided with spigots, small vials or bottles may be easily refilled and carried by the operators making the routine applications. For example, if the sprayer is of one (1) quart capacity, a 5 oz. vial or bottle of the 35% DDT emulsion is added to the sprayer which is then filled by dipping in water. This makes 1 quart of 5% spray solution; enough to cover one acre of mosquito breeding water surface.

If a 5% oil solution is used, it is suggested that it be carried to the field mixed ready for spraying, in drums provided with spigots. In this case it will be necessary for the operator to return to the drum each time that he wishes to refill his sprayer. Treat at rate of one stroke per square yard of mosquito breeding water surface.

(b) If it becomes necessary to use the 4 gallon open head air pressure sprayers or the knapsack sprayers for larvicidal work, the solution should be diluted to 1% and applied at the rate of 5 quarts per acre. To carry 99% oil, or water, through mud and muck with only 1% of the toxic DDT in a sprayer of this type makes it a cumbersome and undesirable method of distribution for larvae control. These sprayers also possess the toxic hazard of leaking DDT oil solutions on the back of the operator.

(c) Although DDT dust is 10 to 100 times as toxic to mosquito larvae as Paris Green, in general, it is not practical to use it since an oil solution or water emulsion spray has been found to be much more desirable. DDT's greatest use as a 10% powder is for the control of lice and should not be used for mosquito control purposes when other more desirable forms of DDT are available. However, if necessity demands it, the 1% dust may be applied with an ordinary Paris Green hand duster at the rate of 10 pounds per acre which equals 0.1 pound pure DDT per acre.

(d) Drip cans, plaster of Paris covered DDT "eggs", bombs and hand grenades filled with DDT, have been tested. DDT has no magic powers of spreading itself over water surfaces and in dispersing this small amount of material, great care must be taken to see that it is introduced into the entire surface, particularly where there are rafts and booms of floatage that will cut its access to sheltered areas where breeding may be intense. Trials involving the addition of DDT to irrigation water at its source have not been particularly successful.

These methods of application are not recommended for routine mosquito control operations because of :

(1) the time and cost required for preparation;

(2) the inability to apply the proper dosage at the proper places; and

(3) the limited area that will be affected.

2. Power Sprayers

a. Various types of power sprayers, with paint spray gun attachments, have been mounted on Jeeps and used to control mosquito larvae in roadside breeding places and to spray army barracks for residual effects. In special circumstances, (in camps or in thickly populated areas) such a spray unit will be extremely useful, but for the most part, it is not portable enough to be of practical value for routine field applications of DDT. However, smaller units have been developed, that are portable and very satisfactory.

b. Special oil boats have been used for a number of years in the routine applications of oil to mosquito breeding shorelines of reservoirs and lakes. The standard larvicide, in the past, has been a 9 to 1 mixture of black oil and kerosene applied at rates of 25 to 40 gallons per acre as a 5% oil solution mechanically mixed with 95 parts of water as it is pumped from the boat to the shoreline in a "fire hose" type of stream. Some tests were run by the Tennessee Valley Authority with these boats using a 2.5% DDT solution in kerosene and applied at the rate of approximately 2 quarts per acre. This rate of application proved highly effective. The routine use of DDT will result in a decrease of over 95% in the amount of oil formerly used and will, therefore, effect a considerable reduction in the cost of boat oiling operations.

3. Residual Spraying (for Adult Control)

For field operations the DDT concentrate is carried to the project site in 55 gallon oil drums or in 5 gallon cans, depending upon the extent of the operations. The 35% emulsion concentrate affords a great saving in transportation space. Hand sprayers of the Hudson Industrial or Army decontamination type having a 4 gallon capacity will be commonly used for residual house spraying, until more desirable "inventions" become available.

One part of the concentrate is placed in the sprayer and 13 parts of water added. Marking the proper level in the sprayer will avoid the necessity for measuring out 13 parts of water each time the tank is refilled. This is best done by soldering pieces of wire on the insides of the sprayers. After the cover is replaced, the tank is inverted several times to insure thorough mixing; the air pressure is brought up to approximately 50 pounds by 60 strokes of the air pump and the 2½% water emulsion spray is ready for application as a residual house spray. The operator will practice spraying 190 sq. ft. per minute using slightly less than 1 quart of spray solution. (Nozzle No. ¼T8002 discharges 757 c.c. per minute at 40 pounds pressure, enough to spray 190 sq. ft. at the rate of 100 mg. per sq. ft.). Hold the nozzle about 18" from the wall. Begin at the bottom corner, move the spray upward in a vertical line until the top is reached. Watch the spray pattern and move the spray evenly and steadily in a straight sweep the width of the spray pattern. Do not leave dry spots nor spray one spot excessively. In making practical field applications the operators spray the walls until "wet" but not to excess run off. A two man spraying crew will do about 20 houses per day. Some workers move the furniture into the middle of the room and cover it for protection; others spray everything, as it stands in the room, that mosquitoes are likely to touch. Food and water, left open in the kitchen, is covered with a cloth or paper.

Screens are most economically treated by painting the solution on with a paint brush.

Residual house spraying meets enthusiastic approval of the inhabitants of an endemic area. The morale effect is tremendous and should not be overlooked.

It has been shown that the malaria chain of transmission can be broken by spraying houses in endemic areas with pyrethrum ("flit") sprays at weekly intervals. Actually this type of spraying kills only the adult mosquitoes that happen to be resting in the house at that particular time. When a house is sprayed with DDT it is effective for 8 to 10 continuous weeks. It seems logical to assume that, if a mosquito enters a DDT treated house, bites a malaria patient, and escapes without first touching a DDT treated surface; before 12 days have passed and she is capable of transmitting malaria sporozoites to another person, her luck will run out and she will come to rest on a DDT treated surface and will be killed; thus breaking the chain between merozoite and sporozoite formation.

4. AIRPLANE

a. Dusting

For many years airplanes have been used successfully in the control of certain agriculture pests and for the routine application of 2 - 5% Paris Green dust for the control of anopheline mosquito larvae. In 1943 and 1944 the Tennessee Valley Authority ran a series of field tests to determine the feasibility of applying DDT dust larvicides by means of the Stearman airplanes used by the authority to distribute Paris Green for the control of malaria carrying mosquitoes. It was found that DDT is a rather sticky substance which clogged in the plane hoppers and fell in large chunks. It was necessary to reduce the concentration of DDT to 5% before a satisfactory dusting mixture could be obtained. Although the 5% DDT dust gave very satisfactory results, its use was objectionable because the high percentage of inert diluent greatly decreased the pay load of the dusting plane. Attention was therefore shifted to the airplane distribution of oil solutions of DDT.

b. Spraying

(1) The Piper Cub airplane (NE-1, Army L-4-B, 65 H.P. continental engine) equipped with a spray unit developed by the U.S.D.A. Orlando, Florida, Laboratory has proven satisfactory for small scale spraying with a 5% oil solution of DDT applied at the rate of 0.1 to 0.2 pounds per acre with effective swath widths of 40 feet. The cub plane has a definite place for limited operations, but it is not the answer to all of the requirements for the dispersal of DDT sprays from planes. It has a small load capacity. The load (27 gallons), however, is adequate for the treatment of 50 acres at the army dosage rate of 2 quarts of 5% solution per acre. It has a short flight range of about 2 hours and can treat approximately 300 acres per day. It has the advantage of being able to land and take off on small temporary fields. The recommended spray for cubs consists of 95% oil (composed of equal parts of lube oil and diesel oil, or kerosene) and 5% DDT. The spray load in this type of plane is likewise limited because of the size of the plane and the high percentage of DDT diluent.

(2) The large T.V.A. Stearman (450 H.P.) dusting plane was equipped with a spray unit. One of the reserve gasoline tanks located in the top wings of the plane was used to hold the DDT solutions. A small wind driven oil pump attached to the landing gear superstructure supplied the necessary pressure, and the spray was discharged through seven whirl-disc nozzles located on the trailing edge of the lower wings of the plane. This unit proved to be more satisfactory than the cub unit because it carried a heavier load and sprayed greater swath widths. It soon became apparent that a better solvent (with a high boiling point and low viscosity) was needed to dissolve higher percentages of DDT. Velsicol NR-70 met these requirements and 15% to 40% DDT in this solvent gave larval control over 200 to 300 swath widths when applied at the rate of 0.1 pounds per acre. This spray consisted of droplets from 100 to 500

microns in diameter and at this rate of application did not form a complete surface film.

c. Thermal Aerosols

(1) In an effort to obtain a finer breakup of the DDT solutions than could be obtained with airplane spraying equipment, attention was turned toward the use of exhaust generators to produce thermal aerosols by injecting a 20% DDT - Velsicol NR-70 solution into the exhaust manifold of the airplane. After intensive experiments by T.V.A. and O.S.R.D. a very satisfactory method was developed for producing an aerosol with 90% of the droplets with diameters in the 5 to 100 micron range. A small percentage of the material was in the size range of smoke particles and the aerosol cloud produced was quite visible. The aerosol is rapidly carried to the water surface by the down draft from the airplane propeller. Vegetation is penetrated very effectively. Larval kills of 90% or better have been obtained with this unit over swaths as wide as 300 feet at actual treatment rates as low as 0.04 lbs. DDT per acre. When DDT thermal aerosol are distributed at the rate of 0.5 pounds per acre it is effective as a mosquito adulticide. It not only kills them in their diurnal resting shelters, but will persist for some time on the vegetation and will kill newly emerged mosquitoes when they touch the DDT residual particles.

(2) The Army and Navy are using various types of aircraft equipped with special devices for widescale distribution of DDT, for mosquito control. Details regarding this special equipment and methods of distribution cannot be given in this report since this information is still classified as "Secret" and "Confidential".

(3) The Stearman PT-17, 220 H.P. aircraft is about one-half the size of the T.V.A. plane. These primary training planes are available and are being equipped with thermal aerosol generators for use in malaria control operations. This method of DDT distribution by aircraft is the latest and most sensational

development in mosquito control. It is the only type of equipment that has been developed that will distribute the small amounts of DDT required per acre. This method of application makes it possible to control mosquito breeding places that in the past have been inaccessable and impossible to control by hand methods. In practically all situations a plane can do a more thorough job in a few minutes than a ground crew can do in several days. However, for very limited operations or for treatment of small isolated breeding spots, hand methods of application are more practical, economical, and should be continued.

d. Field Organization and Flying Technique

(1) It will be necessary to organize the work and train field personnel for special tasks in order to keep the airplane operation moving smoothly. Sub-bases with supply warehouses should be established on all conveniently located airports. Special personnel will be necessary to make inspections, ground observations, load the plane, and flag or mark the areas to be treated, etc.

(2) The pilot is the key man and must be specially trained for this type of flying. The success of this project depends on his attitude and his thorough understanding of all aspects of the problem.

(3) A few hours in the early morning (break of dawn) affords the best flying weather for this type of work. To get a wider coverage, it is better to fly crosswinds as low as safety permits. It is not safe to fly when the wind is more than 20 m.p.h. The flying formula is as follows:

$$\text{Height of plane in flight} = \frac{1000}{\text{Wind velocity (M.P.H.)}}$$

VI. <u>CAUTIONS IN THE USE OF DDT:</u>

1. DDT is highly toxic to insects in minute quantities but only slightly toxic to man and animals. DDT should not cause serious damage to man when carefully used and the proper precautions taken. As a powder, it is not toxic to the skin and not so much so when taken internally; but <u>in oil solutions, it is often toxic to the skin and very toxic when taken internally.</u> The oil solution is absorbed through the skin and prolonged exposure and continuous contact (with a leaky knapsack sprayer, for example) should be avoided. When such contact is made, wash it off with soap and water.

2. After using DDT in a water emulsion, the sprayers and nozzles should be cleaned with hot soap and water or an oil solution, as the water emulsion (even with fresh water) tends to rust the equipment.

3. If too high a concentration of DDT is applied (more than 1 part to 10 million parts of water, or as much as 1 pound per acre), it may kill fish and other wild life.

4. Careful entomological studies and observations should be made before making indiscriminate, wide scale applications of DDT to areas where honey bees, silkworms, or other useful insects might be killed. In many places, however, it may become desirable to use DDT for the control of various insect pests which cause millions of dollars worth of damage to agriculture.

5. DDT is not a "cure all" for mosquito control. Other appropriate standard methods and precautions will have to be employed according to the circumstances. For example, DDT does not repel mosquitoes nor kill quickly; therefore, pyrethrum sprays, bed nets, or repellents would furnish more protection to a traveller passing through an endemic area than DDT spraying. Drainage, house screening, and DDT spraying would be more desirable for permanent control.

6. In spite of its remarkable insecticidal properties, DDT is practically useless unless properly distributed over the area inhabited or frequented by the insect species for which control is desired.

VII. SUMMARY:

The discovery of DDT has revolutionized mosquito control methods. Minute quantities absorbed upon contact causes death to insects in a peculiar, fantastic, physiological sort of way, and continues to kill for long periods of time after the original application. It is applied at rates from 0.1 to 0.5 pounds per acre as a larvicide and from 100 to 200 mg. per sq. ft. as an (residual) adulticide. It has a wide range of application and is effective when applied as a dust, an oil solution, a water emulsion, or as a thermal aerosol.

Certain hand equipment has been found useful in the distribution of DDT, but the newest, most sensational, and effective method is by airplane as a thermal aerosol. This method of application makes malaria control possible in vast areas that, in the past, have been inaccessable and impossible to control by hand methods.

Intensive research is being conducted by various agencies in an effort to develop better equipment and to find more effective methods of applications.

Many new developments and improvements will be made. As these improvements become applicable to field condition, they should be adopted. Although much remains to be learned about DDT, its immediate utilization for insect control should be prompt and widespread, taking priority over all other insecticides.

MEASUREMENT

Measurement plays a very important part and is very frequently used in all of our daily lives. Have you ever stopped to think how often you use units of measurement each day. You drive two miles to the plant each morning. You buy a pound of butter at the grocery store (or do you use margarine?). You sleep eight hours each night (or are you troubled with insomnia?). These are just a few of the units of measurement that we use, but they represent three basic methods of expressing all measurement.

What is a unit of measurement?

Do you know that all measurement can be expressed in only three units, with which you are familiar and which you use every day? These units are length, weight, and time. In this country we use inches, feet, yards, miles, etc., as units for measuring length. We use ounces, pounds, tons, etc., as units for measuring weight. We use seconds, hours, days, etc., as units for measuring time. Try as you may, it is impossible to find a unit of measurement that cannot be broken down into these three units. Let us test this out and see for ourselves.

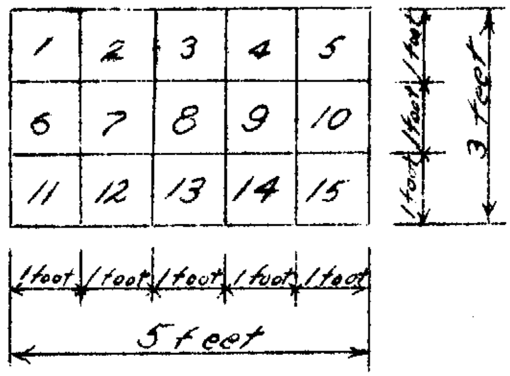
How long is "length"?

As we have said, length is measured in inches, feet, yards, miles. All of these units of measurement are interchangeable, or they can all be broken down in terms of each other. The table on page II shows how this can be done. You will note that 1 foot = 12 inches and that 1 yard = 3 feet. In the same way, 1 foot = 1/3 yard and 1 inch = 1/12 foot. Why is this so? It is so because men have agreed that it is so--it is a matter of definition. When you can't find your shoes you say, "Where in the 'Sam Hill' are my shoes?" Shoes is the name for the leather gadgets that we wear on our feet, and we have all learned the word and what it stands for. The same applies to all of the names given units of measurement. Then, when we say "yard" we know what we are talking about, since we have agreed on what a yard is: it is 3 feet or 36 inches. We have now learned to measure length or to measure how long something is. When we say something is "6 feet long" we are measuring it in one direction. But suppose we want to measure it in two directions? Well, we just measure the length in each of the directions, and we can convert both of these figures to a single unit which we call "area".

What is "area"?

Area is the measurement in two directions. When measuring length we used inches, feet, etc., but when we measure area it is expressed in square inches, square feet, square yards, and square miles. The term "square" has a simple meaning in arithmetic--it means a number multiplied by itself. In other words if the chair seat you are now sitting on is 1 foot long in each direction you are sitting on 1 square foot of area. Suppose we have something a little larger, such as the top of your desk.

It is 5 feet long in one direction and 3 feet long in the other direction--in other words, 5 feet long by 3 feet wide (see sketch). Knowing that the measurements are 5 feet by 3 feet, we can find the area by multiplying the length by the width. In other words, the area of the desk top is 5 feet x 3 feet = 15 feet^2 or 15 square feet. If you don't believe it count the squares in the sketch. Now perhaps we have introduced something that confuses you. We have said that the area is 15 feet^2 or 15 square feet. Don't let it throw you. They mean the same thing. The term feet^2 means square feet or feet times feet. Nothing to it, was there?



One thing that you must remember is that when working problems of measurement we not only multiply or divide the numbers, but also the terms or units, such as feet, gallons, pounds or whatever they may be. In the example above we multiplied the number 5 by 3 and got 15. We also multiplied feet by feet and got feet^2 or square feet. Combining the numbers with the units our answer was 15 feet^2 or 15 square feet. You have now learned to measure the area of a rectangle or square, but suppose you want to measure the area of an object of a different shape. Well, you just use the formula for that shaped object as shown on page 12. The answer is again written in square feet. O.K., we now know how to measure area or to measure something in two directions or two dimensions. But many things have three dimensions--how do we measure those? Simple, we just measure the length in each of the three directions or dimensions, and we can convert all three of these figures to a single unit which we call "volume".

What is "volume"?

Volume is the measurement in three directions. When measuring length we used inches, feet, etc., and when measuring area we used square inches, square feet, etc., but when we measure volume it is expressed in cubic inches, cubic feet, cubic yards, cubic miles. Again the term "cube" in arithmetic is the source of the expression "cubic unit of length" or "volume". The cube of a number is that number multiplied by itself three times and is written with a 3 above the right side of the number cubed. Thus, 5 x 5 x 5 = 5^3 = 125. In the same manner we can multiply the "units of measurement". Thus, if we multiply 5 feet by 5 feet by 5 feet the answer is 5^3 feet^3 or 125 feet^3 or 125 cubic feet.

The volume of a rectangular tank can be found by multiplying its length by its width by its height. Let's suppose your primary tank is a rectangular tank 20 feet long by 10 feet wide by 8 feet deep. What is its volume?

$$20 \text{ feet} \times 10 \text{ feet} \times 8 \text{ feet} = 1600 \text{ feet}^3 \text{ or } 1600 \text{ cubic feet.}$$

You now know how to find the volume of a rectangular object. The volume of any solid object can be found in the same way, and in every case the answer will be stated in cubic inches, cubic feet, etc. The formulas on page 12 will help you obtain the volume of the tank or devices you usually meet in the treatment works.

Are you still with us? It hasn't been hard to understand so far, has it? Well, the rest isn't hard either. Now, in addition to measuring volume in cubic inches or cubic feet we frequently want to measure it in gallons. How do we do that? You remember that the units of measurement are as they are because men have agreed on them. The same applies to the definition of a U. S. gallon. We have agreed that one gallon is equal to 231 cubic inches. One cubic foot is about 7.5 gallons. In the example above, we found that the volume of the tank was 1600 cubic feet or 1600 feet^3. To find its volume in gallons, we multiply the volume in cubic feet by the number of gallons in one cubic foot. Therefore,

1600 cubic feet x 7.5 gallons per cubic foot =

$$1600 \cancel{\text{feet}^3} \times \frac{7.5 \text{ gallons}}{\cancel{\text{ft.}^3}} = 12{,}000 \text{ gallons}$$

Note that when writing gallons per cubic foot in an equation it is written $\frac{\text{gals.}}{\text{ft.}^3}$ This will apply to any expression with the word "per" in it that we use here. Other expressions written in the same way are pounds per square inch = $\frac{\text{lbs.}}{\text{in.}^2}$; cubic feet per second = $\frac{\text{ft.}^3}{\text{sec.}}$. Note also that in the problem above we divided the units as well as multiplied the numbers before those units. $\frac{\text{Ft.}^3}{\text{Ft.}^3}$ = 1 and thus cancel each other, leaving the only remaining unit as gallons. Now we have learned how to measure volume. Let's go to another unit of measurement called "velocity".

What is "velocity"?

Velocity is defined as the change of position per unit of time or as the rate of change of position. In other words velocity is speed. When your car is going 80 miles per hour, the velocity of your car is 80 miles per hour. Also, your car is a lot better than mine, because mine won't go 80 miles per hour. When we say the velocity of the car is 80 miles per hour we mean that at that speed the car will travel 80 miles in one hour. Velocity of flow of water is no different except that we express it in different terms, usually feet per minute or feet per second. To find the velocity of flow we divide the distance traveled by the time it took to travel that far. Thus, if an object in a flowing stream moves 30 feet in one minute the velocity is 30 feet per minute. To convert this to velocity in feet per second we figure it as follows:

$$30 \text{ feet per minute} = \frac{30 \text{ feet}}{1 \text{ minute}} = \frac{30 \text{ feet}}{60 \text{ seconds}} = \frac{0.5 \text{ feet}}{\text{second}}$$

$$= 0.5 \text{ feet per second or } 0.5 \text{ ft./sec.}$$

Note that instead of saying feet divided by seconds we commonly say feet per second. That is velocity. Easy, wasn't it? Now let's go to another term of measurement called "rate of flow."

What is "rate of flow?"

We have said that velocity is the change of positions per unit of time. Applied to a stream of water it is the speed of that stream of water. We found how fast that stream of water was flowing at a certain spot, or, in other words, we found the change of position. However, we did not find out how much water was flowing in the stream past that spot in that unit of time. That is rate of flow. In other words, rate of flow is the volume of water flowing past a given spot in a unit of time. Rate of flow is usually expressed in volume as gallons per unit of time. Pump capacities are usually expressed in gallons per minute, and report sheets on plant operation ask for rate of flow in million gallons per day.

In the example above we found that the stream moved 30 feet in one minute or that its velocity was 0.5 ft./sec. Now let us suppose that the stream was 1 foot deep and 2 feet wide. In other words, the area of the cross section of the stream is 1 foot by 2 feet = 2 feet^2 or 2 square feet. We have also found that its velocity was 0.5 ft./sec. To find the rate of flow of the stream, we merely multiply the cross-sectional area of the stream by its velocity. In an equation it is done like this:

$$\text{Rate of flow} = \text{area x velocity} = 2 \text{ ft.}^2 \times 0.5 \frac{\text{ft.}}{\text{sec.}} = 1 \frac{\text{ft.}^3}{\text{sec.}}$$

$$= 1 \text{ ft.}^3 \text{ per second} = 1 \text{ cubic foot per second.}$$

That is how we find the rate of flow of a stream. Suppose we wanted to find the rate of flow of a pump. We could do it in the same way if we knew the area of the cross section and the velocity of flow in the pipe at the pump. However, we usually have an easier way of finding the capacity or rate of flow of a pump. Usually we can measure the amount of water pumped in a certain period of time and from that determine the rate of flow of the pump. Let us test the capacity of a pump by pumping into an empty rectangular tank 30 feet long by 10 feet wide by 6 feet deep. We find that it takes the pump one hour and fifteen minutes to fill the tank. The pumping rate or rate of flow of the pump is then figured as follows:

To find the volume pumped....30 feet x 10 feet x 6 feet x $\frac{7.5}{ft.^3}$ gals. =

first multiply the numbers....30 x 10 x 6 x 7.5 = 13,500

then multiply and divide the units....$ft. \times ft. \times ft. \times \frac{gals.}{ft.^3}$ =

$$\cancel{ft.^3} \times \frac{gals.}{\cancel{ft.^3}} = gals.$$

or do both operations in one step....$13{,}500\ \cancel{ft.^3} \times \frac{gals.}{\cancel{ft.^3}} = 13{,}500$ gals.

The volume pumped is therefore 13,500 gallons. This was pumped in one hour and 15 minutes or 75 minutes. The rate of flow or rate of pumping is therefore 13,500 gallons per 75 minutes. We have said that pump capacities were expressed in gallons per minute, so let us convert the rate of flow to gallons per minute:

$$13{,}500 \text{ gals. per 75 minutes} = \frac{13{,}500 \text{ gals.}}{75 \text{ min.}} = 180 \text{ gals. per minute} = 180 \text{ gals/min.}$$

That wasn't very hard, was it? We can make this entire computation in one step. It looks more complicated, but it really isn't. Here it is:

$$\frac{30\ \cancel{ft.} \times 10\ \cancel{ft.} \times 6\ \cancel{ft.} \times 7.5 \text{ gals.}}{\cancel{ft.^3} \times 75 \text{ min.}} = 180 \text{ gals./min.}$$

Now suppose we want to convert this to million gallons per day. We know there are 60 minutes in an hour and 24 hours in a day, or 1440 minutes in a day. If the pump will pump 180 gallons in one minute, in one day it will pump

$$\frac{180 \text{ gals.}}{\cancel{min.}} \times \frac{1440\ \cancel{min.}}{day} = \frac{259{,}200 \text{ gals}}{day} = 259{,}200 \text{ gals. per day}$$

= 0.2592 million gallons per day or 0.2592 MGD

Another common rate of flow used in treatment plants is gas produced or used and this is expressed in cubic feet per day.

In the first example on rate of flow, the one about the stream, we found the rate of flow of the stream by multiplying the cross-sectional area of the stream by the velocity or velocity of flow of the stream. Suppose we know the rate of flow of the stream and want to find the velocity of flow? We would then merely work the problem in reverse or divide the rate of flow by the cross-sectional area to find its velocity. That's easy, isn't it? Let's try it on a little tougher problem. Suppose the rate of flow through a grit tank is 1.296 MGD (million gallons per day) and the tank is 2 feet wide and the water depth is 5 feet. We want to find the velocity of flow through the tank expressed in feet per second. Let's go.

(1) Express 1.296 MGD in terms of gallons per second since we want our answer in feet per second:

$$1.296 \text{ MGD} = 1.296 \text{ million gallons per day} = 1{,}296{,}000 \ \frac{\text{gals.}}{\text{day}}$$

1 day = 24 hours, and 1 hour = 60 minutes and 1 minute = 60 seconds; therefore, 1 day = 24 x 60 x 60 = 86,400 seconds.

Since the rate of flow is 1,296,000 $\frac{\text{gals.}}{\text{day}}$ and 1 day has 86,400 seconds; therefore:

$$1{,}296{,}000 \ \frac{\text{gals.}}{\text{day}} = \frac{1{,}296{,}000 \text{ gals.}}{86{,}400 \text{ seconds}} = 15 \text{ gals. per sec.}$$

(2) Our next step is to convert gallons to cubic feet; or let's take the 15 gals. per sec. and convert it to cubic feet per sec.

We know that 1 cu. ft. = 7.5 gals., or 1 gal. = $\frac{1. \text{ cu ft.}}{7.5}$ or 1 gal. = .133 cu. ft.

$$15 \text{ gals. per sec.} = \frac{15 \text{ gals.}}{\text{sec.}} = 15 \times \frac{.133 \text{ cu. ft.}}{\text{sec.}} = 1.995 \text{ cu.ft.per sec.}$$

We now have the rate of flow in cubic feet per second. Let's go to the next step.

(3) Find the cross-sectional area of the grit tank. Since it is 2 feet wide and 5 feet deep, its cross-sectional area is:

$$2 \text{ ft.} \times 5 \text{ ft.} = 10 \text{ square feet or } 10 \text{ ft.}^2$$

(4) Now for the last step. To find the velocity we divide the rate of flow in cubic feet per second by the cross-sectional area in square feet.

$$\text{Rate of flow} = 2 \text{ cu. ft./sec.} = 2 \ \frac{\text{ft.}^3}{\text{sec.}} \text{ (Step 2)}$$

$$\text{Cross-sectional area} = 10 \text{ ft.}^2 \text{ (Step 3)}$$

therefore;

$$\frac{2 \text{ ft.}^{\not{3}\,1}}{\text{sec.} \times 10 \ \not{\text{ft.}}^{\not{2}}} = 0.2 \ \frac{\text{ft.}}{\text{sec.}} = 0.2 \text{ ft./sec.}$$

Did cancelling out those exponents throw you? (Exponents are those numbers at the upper right hand corner of ft.) If they did, let's explain a little further. When we divide $ft.^3$ by $ft.^2$, we subtract the exponent 2 from the exponent 3 leaving an exponent of 1. (Remember that when we multiplied ft. x ft. x ft. we added exponents to get $ft.^3$. This is just the reverse.) We can prove this method of subtracting exponents as follows:

Our rate of flow was $2 \frac{ft.^3}{sec.} = \frac{2 \text{ ft. x ft. x ft.}}{sec.}$

Our cross-sectional area was $10 \text{ ft.}^2 = 10$ ft. x ft.

Then dividing rate of flow by area we get $\frac{2 \text{ ft. x } \cancel{ft.} \text{ x } \cancel{ft.}}{\text{sec. x } 10 \cancel{ft.} \text{ x } \cancel{ft.}} = 0.2$ ft./sec.

Got it now?

We've learned to measure quite a few things around the plant by now. There are only a couple more that we need know. Let's try pressure.

What is "pressure"?

Webster says it is the force or thrust exerted over a surface divided by the area of the surface. What does it mean? It means that when you drive your car into a filling station and ask the attendant to put 30 pounds per square inch of air in your tire, the pressure on every square inch of that tire is 30 pounds. There are several different ways of expressing pressure, but they are all expressions of the same action. Pressure of water is usually expressed in pounds per square inch. Atmospheric pressure is usually expressed in inches of mercury. Gas pressure is usually expressed in inches of water. Let us see how they are all related to each other.

Pressure is produced by the weight of a substance against the surface upon which it is bearing. Then when we say that the gas pressure is 8 inches of water we mean that the pressure in the gas line is equal to that produced by a column of water 8 inches high. We know that 1 cubic foot of water weighs 62.4 lbs., or, to say it differently, water weighs 62.4 lbs. per cubic foot. Picture this cubic foot of water in the form of a cube one foot long, one foot wide, and one foot high. Therefore, we have a column of water one foot high bearing on an area of one square foot. The pressure produced by the column of water one foot high is figured as follows:

Water weighs 62.4 lbs. per cubic foot, or $\frac{62.4 \text{ lbs.}}{ft.^3}$, or $\frac{62.4 \text{ lbs.}}{\text{ft. x ft. x ft.}}$

The water is bearing on an area of 1 square foot or 1 ft.^2 or 1 ft. x ft.

1 ft.^2 or 1 ft. x ft. = 12 inches x 12 inches = 144 in.^2 or 144 sq. in.

Let's substitute square inches for square feet in the above expression for the weight of water as follows:

Water weighs $\frac{62.4 \text{ lbs.}}{\text{ft.}^3} = \frac{62.4 \text{ lbs.}}{\text{ft. x ft. x ft.}} = \frac{62.4 \text{ lbs.}}{\text{ft. x 144 sq.in.}} = \frac{0.434 \text{ lbs.}}{\text{sq. in. x ft.}}$

or 0.434 pounds per square inch per foot.

In other words, a column of water 1 foot high produces a pressure of 0.434 pounds on each square inch of the surface on which it is resting.

The pressure of a column of water 1 inch high can be computed as follows:

1 foot = 12 inches

Substituting inches for feet in the expression $\frac{0.434 \text{ lbs.}}{\text{sq. in. x ft.}}$ we have

$\frac{0.434 \text{ lbs.}}{\text{sq. in. x 12 in.}}$ = 0.036 lbs. per square inch per inch.

In other words, a column of water 1 inch high produces a pressure of 0.036 pounds on each square inch of the surface on which it is resting.

Suppose we want to find the pressure of a column of mercury 1 inch high.

> Mercury weighs 13.55 times that of water. Since a 1 inch column of water produces a pressure of 0.036 pounds per square inch, 1 inch of mercury = 0.036 pounds per square inch per inch x 13.55 = 0.49 pounds per square inch per inch.

In other words, a column of mercury 1 inch high produces a pressure of 0.49 pounds on each square inch of the surface on which it is resting.

That wasn't too bad, was it? Now let's get to that term which may have seemed complicated to you: concentration.

<u>What is "concentration"?</u>

Concentration is the relative amount of one substance in another. In other words, when we say that ivory soap is 99 $\frac{44}{100}$ per cent pure, the concentration of the impurities in the soap is $\frac{56}{100}$ per cent (100 per cent minus 99 $\frac{44}{100}$ per cent). Now, instead of ivory soap let's think of your plant effluent. You know that it is principally water and that there are also some solids carried in it. The concentration of solids in it could be expressed in per cent, but since the percentage figures would be so small that they would be hard to work with, we use a different term called "parts per million." What does it mean? It means weight units per million weight units. In other words, pounds per million pounds, tons per million tons, grams per million grams, milligrams per million milligrams. Are you acquainted with the terms "grams" and "milligrams"? They are units of weight just as ounces and pounds. One milligram is one thousandth of one gram. The term "milli" applied to any unit means one-thousandth of that unit. There are 28.35 grams in the ordinary ounce. In obtaining the concentration of a material in sewage, we must determine it by laboratory methods. In the laboratory we determine the small quantities of impurities in the weight units of milligrams or thousandths of grams. If we measure the milligrams of impurities in a liter of sample, we obtain the concentration in parts per million. One liter of water weighs 1000 grams or 1,000,000 milligrams. Thus, milligrams per liter is milligrams per million milligrams or parts per million parts. Note here also that a liter is 1.06 quarts and that 3.79 liters are equal to one gallon.

In plant operating reports we know the analysis in terms of parts per million and wish to use this data together with flow data to obtain the pounds of material removed. Here we wish to change parts per million removed and million gallons per day into pounds removed per day. This is done as follows:

> Suppose 150 parts per million of suspended solids are removed from a sewage and the rate of sewage flow is 0.5 MGD or 500,000 gallons per day.
>
> In order to use parts per million parts, we must express 500,000 gallons per day in the weight units we want for our answer, namely, pounds.
>
> One gallon weighs 8.34 lbs.
>
> $$0.5 \text{ MGD} = \frac{0.5 \text{ million } \cancel{\text{gals}}}{\text{day}} \times \frac{8.34 \text{ lbs.}}{\cancel{\text{gal.}}} = \frac{4.17 \text{ million lbs.}}{\text{day}}$$

We find that 150 parts per million of suspended solids were removed, which means that 150 pounds per million pounds of sewage were removed. In order to obtain the suspended solids removed per day, we must multiply this factor by the million pounds of sewage per day. Thus,

$$4.17 \frac{\cancel{\text{million pounds}}}{\text{day}} \times \frac{150 \text{ pounds}}{\cancel{\text{million pounds}}} = 626 \frac{\text{pounds}}{\text{day}} \text{ or 626 pounds per day.}$$

Likewise, concentration of sludges is expressed in per cent which is parts per 100 parts, pounds per 100 pounds, tons per 100 tons, and grams per 100 grams. The use of per cent is similar to the use of parts per million. Thus 15,000 gallons of liquid sludge containing 3.0 per cent dry total solids contains the following quantity of dry total solids:

15,000 ~~gals.~~ x 8.34 lbs. / ~~gal.~~ = 125.100 lbs. liquid sludge,

and 3% dry total solids = 3 lbs. dry total solids / 100 lbs. liquid sludge

Then: 125,100 lbs. ~~liquid sludge~~ x 3 ~~lbs.~~ dry total solids / 100 ~~lbs. liquid sludge~~

= 3753 lbs. dry total solids

Well there you have it. It wasn't as hard as you thought it would be. This is all you need to know about measurement to do a good job of operating your plant. Know it well, because these same terms of measurement will be used often in the articles on sewage treatment which will follow this one. Study this article several times, then try explaining measurement to the boys down at the corner drugstore. If you can teach it to them, you know it.

ABBREVIATIONS OF UNITS OF MEASUREMENT

in. = inch	$in.^2$ = square inches	$in.^3$ = cubic inches
ft. = foot	$ft.^2$ = square feet	$ft.^3$ = cubic feet
yd. = yard		
sec. = second		
hr. = hour		
MGD. = million gallons per day		
gal. = gallon		
lb. = pound		

TABLE OF MEASUREMENT UNITS

Linear Measure

1 foot = 12 inches; 1 yard = 3 feet; 1 mile = 5,380 feet

Square Measure

1 square foot = 144 square inches; 1 square yard = 9 square feet; 1 acre = 43,560 square feet.

Cubic Measure

1 cubic foot = 1728 cubic inches; 1 cubic yard = 27 cubic feet; 1 acre foot = 43,560 cubic feet; 1 cubic foot = 7.48 gallons; 1 gallon = 231 cubic inches; 1 gallon = 0.1337 cubic feet; 1 gallon = 3.785 liters; 1 quart = 0.946 liters; 1 liter = 1,000 cubic centimeters.

Weight Measure (Water)

1 gallon = 8.33 pounds; 1 cubic foot = 62.33 pounds.

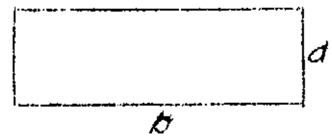
DEFINITION OF PREFIX OF UNITS

mega =	1,000,000	micro =	$\frac{1}{1,000,000}$
kilo =	1,000	milli =	$\frac{1}{1,000}$
hecto =	100	centi =	$\frac{1}{100}$
deka =	10	deci =	$\frac{1}{10}$

AREA FORMULAS

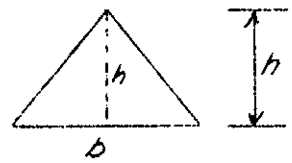
Rectangle

Area $= a \times b$



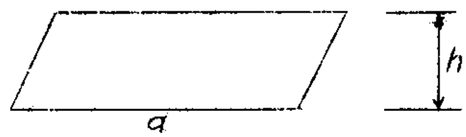
Triangle

Area $= \frac{b \times h}{2}$



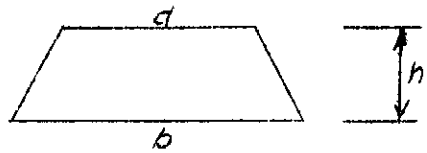
Parallelogram

Area $= a \times h$



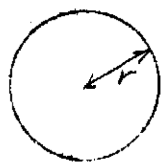
Trapezoid

Area $= \frac{h(a + b)}{2}$



Circle

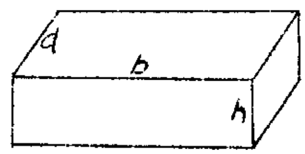
Area $= \pi r^2$
$= 3.1416 \times r \times r$



VOLUME FORMULAS

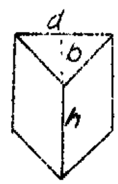
Parallelopiped

Volume $= a \times b \times h$



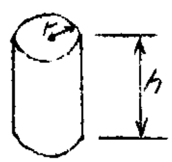
Prism

Volume $= \frac{a \times b \times h}{2}$



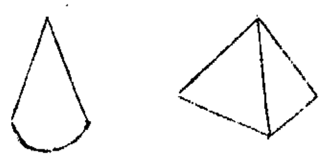
Cylinder

Volume $= \pi \times r^2 \times h$
$= 3.1416 \times r \times r \times h$



Pyramid or Cone

Volume $= \frac{\text{Area of base} \times \text{height}}{3}$



1938

MARSEILLES

OPTIONAL EXCURSION

TO

ARLES & AVIGNON

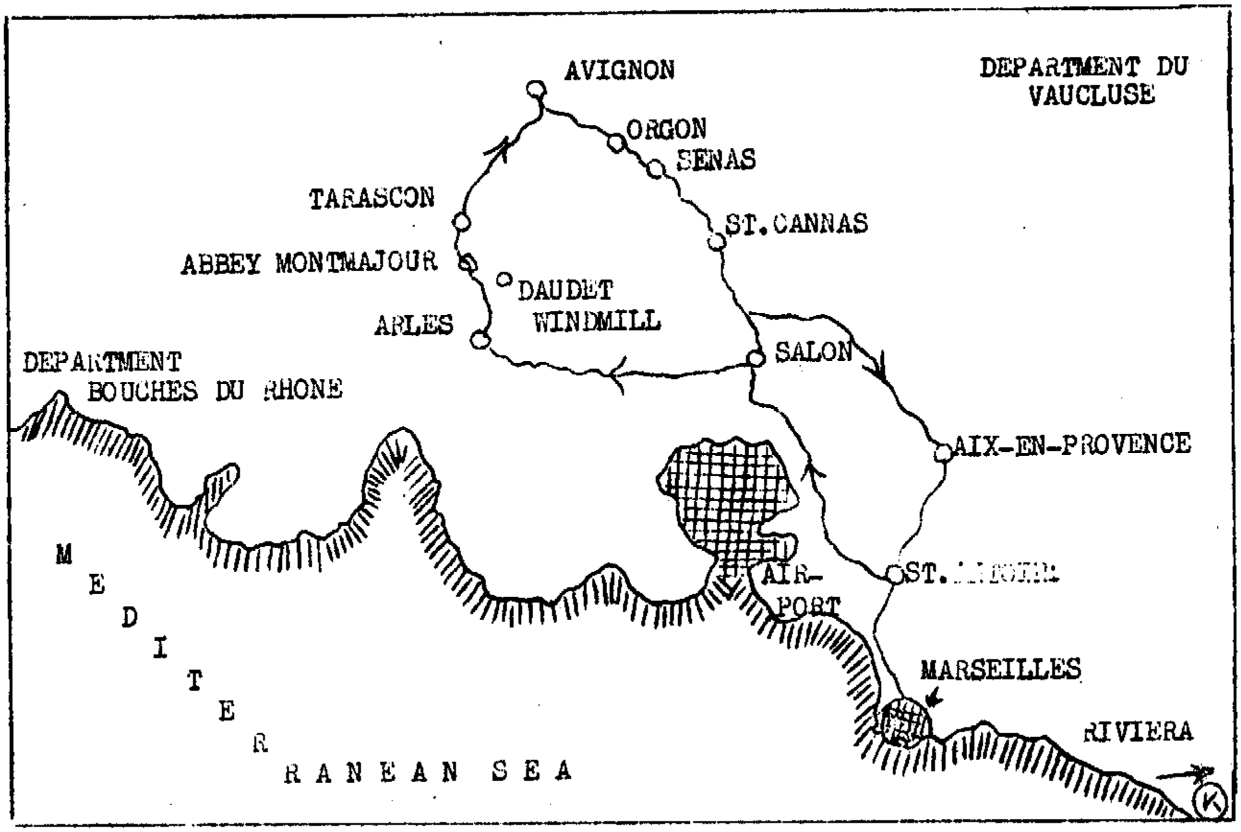
HELPFUL HINTS FOR

YANKEE CRUISERS

BY

"THE MAN FROM COOK'S"

THOS.COOK & SON -WAGONS LITS,INC.
587 Fifth Avenue
New York,N.Y.



ARLES-AVIGNON EXCURSION OF THE YANKEE CRUISE

On Saturday next, through the agency of Thos. Cook & Son, Ltd., the Yankee Cruise will operate an Optional all-day Drive from Marseilles up the Rhone Valley to the historic Towns of Arles and Avignon. Motor-coaches will leave the ship's-side as soon as the ship is cleared and drive directly to the country. Sightseeing will be conducted in Arles before Luncheon there in a hotel located over the Ruins of the old Roman Forum, after which the Drive will continue to Avignon for the visit to the Palace of the Popes.

Return to Marseilles will be made in time for Dinner on board ship or you may alight from the Motor-coach uptown if you wish to have Dinner at one of the famous restaurants of Marseilles and promenade the Boulevards afterwards. The ship is scheduled to sail from Marseilles for Naples at 12 o'clock, Midnight.

The charge of $8.00 is all-inclusive, covering entrance-fees, Luncheon, tips, guide's-services, as well as your transportation.

No Visas are required for this day in France, although it is well to take your Passport ashore with you.

Those holding tickets for the City Tour of Marseilles may exchange them for Arles-Avignon tickets, credit to be applied against the exchange.

RESERVATIONS SHOULD BE MADE BY FRIDAY NOON

NOTE: A responsible agent of the Banking Department of Cook's Marseilles office will come aboard the ship as soon as it docks and change American money into French francs at current exchange rates.

T.C.& S./W.L.INC.
March 11, 1938

Arles, with 17,000 inhabitants, is the capital of an arrondisement in the Department of Bouches-du-Rhone, 54 miles N.W. of Marseilles. It has preserved from its splendid past ancient monuments of the greatest interest. The ancient town, Arelate, was an important place at the time of Julius Caesar, who made it a settlement for his veterans because of its equable climate. Arlesian women, who wear a picturesque costume of their own, are famed for their classical beauty.

Vincent Van Gogh, the modern painter who has become so popular in the last few years, passed the greater part of his last two years (1888-1890) in and about Arles, doing much of his important work in the vicinity. The house in which he lived will be passed on the way to Avignon.

The Cathedral of St. Trophime is the finest Romanesque church in the Provence. It was founded in the 7th Century, rebuilt several times, and restored in 1870. The Main Portal (12th Century) is a masterpiece of graceful arrangement and rich carving. The Choir opens into a beautiful cloister, the massive vaulting of which is supported on heavy piers adorned with statuary, between which intervene slender columns arranged in pairs and surmounted by delicately carved capitols.

The Amphitheatre, or Arena, with 26,000 seats, was constructed in the 2nd Century. Even now it is used as a Bull-Ring in which bull-fights are staged regularly.

The Antique Theatre is of the 3rd Century with 16,000 seats. The famed Venus of Arles was discovered in this place.

The Alyscamps is a vast Gallo-Roman necropolis built on the main road by Aurelius. All that remains is an avenue of tombs leading to the Church of St. Honnorat which was built in the 12th Century.

The Windmill where A. Daudet wrote some of his delightful letters and novels will be seen from the road on the way to Avignon, as will the Abbey Mont Majour, which was founded by St. Cesair and endowed by the Benedictines. The ancient town of Tarascon, of Celtic origin, will be passed through on the way to Avignon.

AVIGNON
(Avenio)

Avignon, with 50,000 inhabitants, 75 miles N.W. of Marseilles, is the capital of the Department of Vaucluse, situated on the left bank of the Rhone, a few miles above its confluence with the Durance. The ramparts which encircle Avignon with their 39 towers and 10 gates date from the 12th Century and were rebuilt in 1349-1370. They are one of the finest examples of medieval fortification in existence.

The Bridge of St. Benezet over the Rhone was built in 1177. It can be clearly seen from the Terrace of the Rock of the Doms on which the 12th Century Cathedral of Notre Dame des Doms is located. This Romanesque Church is almost dwarfed by the Palace of the Popes, a sombre assemblage of buildings which rises at its side.

The Palace of the Popes, as such, was begun by Pope John XXII in 1316, and continued by succeeding Popes until 1370. In its construction (Gothic style) everything has been sacrificed to strength, and although the effect is imposing, the place has the aspect of a fortress rather than of a palace. It was long used as a barrackrs and prison, to the exigencies of which the fine apartments were ruthlessly adapted. It is now municipal property and is maintained as a Museum in which some 18th Century tapestries and other objets d'art have been placed for safekeeping.

T.C.& S./W.L.INC.
March 11, 1938

During the so-called "Babylonian Exile", when the Papacy was removed from Rome for 73 years in the 14th Century, the Palace of the Popes was the residence of 7 Popes, and from 1378 to 1409 of two Anti-Popes. The following table lists the names of these Popes and the periods of their reigns at Avignon:

1. Clement V	1305-1314	4. Clement VI	1342-1352
2. John XXII	1316-1334	5. Innocent VI	1352-1362
3. Benedict XII	1334-1342	6. Urban V	1362-1370
7. Gregory XI	1370-1378		

Anti-Popes:

8. Clement VII 1378-1394

9. Benedict XII 1394-1409

Clement V was the Bishop of Bordeaux at the time of his assuming the Papacy in 1305. He never crossed the threshold of the Eternal City, transferring to Avignon in March, 1309. He feared the loss of ecclesiastical authority and the independence of Papal government would be endangered by the party conflicts then raging in Italy. The French King, Philip IV (The Fair) had become a powerful temporal monarch at this time and, jealous of the revenue which was flowing from his country to Rome, brought pressure on Clement V to maintain his see in France, at Avignon.

John XXII was the Bishop of Avignon when Clement V died, so that when he was chosen by the College of Cardinals in 1316 (after a two-year lapse) he established himself in the episcopal residence hard by the Cathedral. This was the beginning of an ecclesiastical regime entirely Gallicized, as the succeeding Popes, until the Council of Pisa ended the Great Schism in 1409, were French.

Urban V left Avignon on April 13, 1367 and entered Rome Oct.16, 1367 attempting to restore the seat of Papal authority to Rome. Because of impossible political conditions there he returned to Avignon on Sept.27, 1370 and died there Dec.19, 1370.

Gregory XI left Avignon on Sept.13, 1376, entering Rome Jan.17, 1377, remaining there until his death in 1378, when he was succeeded by Urban VI who reigned in Rome from 1378 to 1389. The Roman Succession was then carried down to the present day.

The Great Schism of 1378-1417 brought forth the two Anti-Popes, Clement VII and Benedict XII, who continued to reside at Avignon during the years when the legitimacy of the Succession was in dispute.

* * * * *

The Drive back to Marseilles will pass through Aix-en-Provence, founded by the Romans in 124 B.C. It was the capital of the Provence in the Middle Ages.

Yankee Cruisers will do well to avail themselves of the opportunity to participate in this exceptionally interesting excursion as there will be sufficient time to take the City Tour and Chateau d'If excursions during our Second Call in Marseilles, whereas this Tour can be taken only during this longer stay, First Call.

T.C.& S./W.L.INC.
March 11, 1938

Thos.Cook & Son, Ltd.