

I. Introduction

During the period August 1954 - December 1954 ~~the~~ Arthur D. Little, Inc. served as consultants to the Southern California Air Pollution Foundation. This report summarizes the recommendations that were made to the Foundation during the period.

A. Effect of Smog on the Meteorology of the Los Angeles Basin

The results of the investigations of Neiburger and others have shown ~~it~~ quite clearly that smog conditions in the Los Angeles basin are closely related to the strong inversion that frequently exists above the area. When this inversion layer descends below the level of the mountains surrounding the area, it forms a cap that confines air pollution products in the basin and causes them to reach high concentrations. When the inversion rises above the mountains the pollution products are no longer confined to the basin and are carried away by the wind. Under these conditions the concentration of pollutants does not usually reach objectionable values.

On the basis of all that is known it appears that the density of smog depends in a sensitive way on the height of the inversion layer. When the inversion layer is near the height of the mountains the flux of contaminants out of the basin should increase greatly even with rather small increases in the inversion height.

One of the most important factors governing the height of the inversion and the rate at which smog is carried away is the heat that is received during the day from solar radiation. The importance of solar energy in providing heat to carry pollutants over ~~the~~ the mountains can be seen from the following simple considerations. During the summer months the daily amount of solar energy received per sq cm is of the order of ~~a~~ 700 calories. This energy is sufficient to heat a layer of air 3000 ft thick by about 28°C. It is reasonable to expect

**ROUGH DRAFT**

By...by.....

Date 4-26-55.....

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that most of the solar radiant energy that is absorbed eventually results in heating of the air. We are justified in assuming under a given set of meteorological conditions that the height of the inversion and therefore the rate of smog dispersal will depend on the amount of solar energy being received.

There are good reasons for believing that smog may reflect an appreciable amount of the solar energy incident on the Los Angeles basin. If this is ~~ix~~ true, then under some conditions smog may well be self/intensifying. In other words when smog is present it may aggravate smog producing meteorological conditions by decreasing the heating from solar radiation. This would lead to a ~~vixix~~ vicious circle in which smog once established would maintain itself for days by reducing the dissipating action of solar heating.

An intelligent approach to the smog problem involves determining all of the factors that enter into its formation. It has therefore been recommended that studies be undertaken to determine what fraction of the solar energy normally incident on the basin is being reflected by smog. The starting point for such a study would be to make measurements of the albedo of the basin with and without smog. These data would make it possible to estimate to what extent smog itself is contributing to the meteorological conditions that favor smog.

## Relationship Between Smog and Atmospheric Electricity

It has been suggested in a report of the Stanford Research Institute that atmospheric electrical effects may play a part in the formation of ozone or ozone like compounds in the Los Angeles basin. This might happen if the electric fields were to become large enough to cause point discharge. As a first guess it appears unlikely that the fields could become large enough to cause this effect, however this possibility should not be overlooked.

It is quite a simple matter to measure electric fields and the other variables in atmospheric electricity. It is suggested that ~~these~~ measurements be carried out to determine the electric field and space charge that are associated with smoggy conditions. It is possible that such measurements have already been made by Prof. \_\_\_\_\_ of UCLA or if <sup>that</sup> they have not he would be willing to cooperate in making them.

Even if atmospheric electrical effects play no part in the formation of smog it is quite possible that measurements of

atmospheric electricity may prove to be a valuable index of atmospheric contamination. It has been observed in various regions that air pollution results in large increases in the fair weather electric field and in the space charge with ~~for~~ a correspondingly large decrease in the atmospheric *electrical* conductivity.

## Black Light Absorbing Smoke

In many respects the air pollution problem in the Los Angeles Basin is unique. There appear to be no

## Light Absorbing Smoke, Carbon Dioxide

The air pollution problem in the Los Angeles basin is ~~set apart from~~ differs from that existing in other regions in a number of ways. These ~~problems reflect~~ ~~as~~ ~~not~~ reflect ~~perfectly~~ the meteorological peculiarities of this region and the unusual character and severity of the air pollution sources. One interesting difference between the air pollution in Los Angeles and that existing in the cities of the Midwest and Eastern seaboard is ~~that~~ ~~that~~ that the ~~smog~~ Los Angeles smog is a white reflecting ~~smog~~ aerosol made up of liquid droplets while the contamination in other cities is usually

sided a much darker ground, consisting of  
carbon particles, fly ash, etc.  
Certainly both types of atmospheric pollution  
particles are highly objectionable but  
it appears ~~more~~ ~~concerning~~ ~~as~~ ~~rather~~  
~~a~~ ~~not~~ ~~pro~~ ~~of~~ ~~the~~ that the  
contamination in Los Angeles is even more  
objectionable than in the East.

## Measurement of Concentration of Condensation Nuclei

It appears at the present time that few if any measurements are available of the concentration of condensation nuclei in the Los Angeles area. Rather extensive measurements have been made of ~~the maximum~~ large sized particulate matter and gaseous components in the atmosphere of Los Angeles but the small Aitken nuclei have been neglected. There are several reasons that ~~make~~ <sup>S</sup> it appear desirable to measure the concentration of condensation nuclei.

In the first place it is possible that <sup>0</sup> condensation nuclei may play a role in the formation of ~~the maximum~~ smog particles that is analagous to the role that they are known to play in the formation of fog or cloud droplets. When the humidity in the atmosphere rises to the point that supersaturation occurs the excess water vapor condenses on ~~in~~ condensation nuclei to form droplets. This ~~seems~~ condensation on nuclei takes place at ~~high~~ supersaturations of only a few percent. If no nuclei are present the situation <sup>is</sup> ~~is~~ very different

and saturations of four or five fold are required before condensation can take place. It is possible that condensation nuclei p act as centers for the formation of smog particles and that if no nuclei were present smog might form far less readily. Investigations should be carried out to determine how the formation of ~~is~~ smog is related to the concentration and composition of condensation nuclei.

It is also possible that condensation nuclei may serve as catalysts for ~~the~~ some of the gaseous <sup>u</sup> reactins that are known to take place in the Los Angeles atmosphere. This possibility should be investigated.

Measurements of the concentration of condensation nuclei may prove to be a useful, sensitive tool for investigating the degree and source of air pollution ~~in the Los Angeles area.~~ that is particularly well suited to the Los Angeles area. In general the air in the Los Angeles basin is originally ~~derived from the~~ maritime air from the Pacific Ocean. Measurements that have been made on this air show that it



before it becomes contaminated it has an unusually low concentration of condensation nuclei, usually ~~is~~ less than  $10^3$  per  $\text{cm}^3$ . This is in contrast to the air reaching inland cities or those on the Eastern seaboard which arrives already contaminated with nucle/whose concentrations may be as high as  $10^4$  or  $10^5$  per  $\text{cm}^3$ . The measurement of condensation nuclei should be a very sensitive index of pollution in the Los Angeles area because of the very low background count of the air coming from the ocean.

are known to

All combustion processes ~~XXXXXXXX~~ create very large numbers of condensation nuclei and probably one of the most intense sources is the internal combustion engine. By measuring the condensation nuclei production of various different sources ~~it is possible that it is possible to determine the concentration of these~~ it may be possible to obtain data that will enable one to interpret condensation nuclei concentrations in terms of the most probable source. Wheter or not this can be done, the measurement of nuclei should provide a valluable index of pollution that is independent of the variables that are now being measured.

raising the air and raising the  
 height of ~~incursion~~. The incursion  
 of the fog is grey light in color as  
 is the case in fog. Unlike a ~~fog~~  
~~fog~~ an appreciable amount of the  
 solar energy may be reflected off  
 into space rather than being instead  
 of being absorbed as in the case with  
 a dark colored fog. We may therefore  
 expect the ~~definite~~ that sunlight  
 would deposit a dark fog far  
 more rapidly than a light one.  
 This has in fact been observed in the  
 case of dark and light mokes.  
 Prior to the world war the  
 U.S. Navy used black mokes  
 for screening purposes. It was  
 found that even when they were  
 an incursion grey the water that  
 the solar heating soon caused the  
 black mokes to rise and  
 mix with the atmosphere. When  
 white screening mokes were  
 introduced it was found that  
 these were far more stable  
 would ~~remain~~ not just ~~for~~  
~~so~~ persist for long periods even in

Light Cigarette Smoke  
Black Smoke

(1)

b.)

One of the most striking differences between the Los Angeles smog, and that which exists in eastern cities is ~~the~~ its very light color.

When viewed from an airplane eastern smog is generally a dark gray color, while Los Angeles smog is almost white, like stratus clouds. This difference is probably ~~caused~~ due to largely to the fact that almost no coal is burned in Los Angeles and they felt that air pollution control <sup>has succeeded in</sup> has almost completely eliminated the emission of black smoke. Despite its ~~very~~ unattractive features, black smoke it is possible that the severity and unusual nature of the Los Angeles smog may be due in part to ~~that~~ its very light color as contrasted to eastern smog.

It has been pointed out in the foregoing section that the ~~the~~ sun's rays received from solar radiation plays an important part in

they might, similarly it has  
 been observed that ~~the~~ <sup>clouds</sup> ~~are~~ <sup>are</sup> ~~not~~ <sup>not</sup> ~~so~~ <sup>so</sup> ~~clear~~  
 from Carbon Black manufacturing  
 plants ~~are~~ <sup>are</sup> ~~not~~ <sup>not</sup> ~~up~~ <sup>up</sup> in the sunlight  
 and rises to form ~~any~~ <sup>any</sup> ~~clouds~~  
 when there are no other clouds  
 around; as part of the investigation  
 we have carried out for the  
 Jandani, we have made this  
 local source of this phenomenon  
 occurring at a plant in Texas.

These considerations lead ~~to~~  
 the observation that ~~has~~ <sup>has</sup> ~~been~~ <sup>been</sup> ~~made~~  
 suggest that dark, light-absorbing  
 smokes released during the day ~~time~~  
 might be used to improve  
 the ~~smog~~ <sup>smog</sup> ~~quality~~ <sup>quality</sup> ~~generally~~  
 in Los Angeles. There are several  
 possible ways that this might be  
 done that deserve study. These are  
 as follows.

- 1) General Release of Light Absorbing Smokes  
~~Probably the simplest way that~~

~~much darker~~

light of a sufficient amount of ~~black~~  
 light absorbing smoke particles, released  
 into the Los Angeles basin it should  
 cause a very appreciable increase in  
 the amount of solar energy absorbed  
 by this area. There are <sup>many</sup> no data  
 on the relative reflectivity of the light  
 Los Angeles smog and the dark  
 Eastern smog, but it is not unreasonable  
 to guess that the dark smog  
 might absorb perhaps ten percent  
 more of the daily solar radiation.  
 It can be readily imagined that  
 this additional ten percent of  
 daily heating would be  
 sufficient to raise the height  
 of a 29 ft inversion layer ~~to~~  
 an additional 500 ft. If the  
 inversion is close to the height  
 of the surrounding mountains this  
~~difference in~~ increase in height  
 could greatly increase the rate  
 at which the ~~smog is carried~~  
 pollutants are carried out of the basin.

RESEARCH LABORATORIES FOR THE ENGINEERING SCIENCES

UNIVERSITY OF VIRGINIA

January 29, 1960

THORNTON HALL  
CHARLOTTESVILLE, VA.

TELEPHONE:  
2-2166 EXT. 3020

Dr. B. Vonnegut  
Arthur D. Little, Inc.  
Acorn Park  
Cambridge 40 Massachusetts

Dear Dr. Vonnegut:

I have been referred to you by the Air Pollution Foundation of San Marino, California, as a possible source of information regarding the electrical characteristics of smog.

I am interested in measurements or theoretical values of electric field or potential gradient, conductivities, particle charge, space charge and currents in smog. As I have been unable to locate any of this information in the literature, I would appreciate any references that you can send me.

If you have any of the same information with respect to dust storms, it would also be appreciated.

Very truly yours,

*J. Robert Bounds*

J. Robert Bounds

Laboratory Assistant

JRB:sf

April 26, 1955

Dr. M. Neiburger  
Senior Meteorologist  
Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California

Dear Dr. Neiburger:

59280

I am glad to hear from you that you agree with me on the best procedure to follow concerning the nuclei measurements. It makes sense for you to gain experience with a device that is commercially available.

I would have enjoyed many of the papers at the Symposium and in many ways wish that I had attended. However, I am now busy here getting a new project underway and I really should give it my full attention. I look forward to seeing the written papers presented at the Symposium and I am sure it was a valuable get together.

Concerning our nuclei measuring device, I believe that there are no special shipping instructions. I presume that the boxes we sent it in are perhaps still there and you can return it in these. I believe railway express would be the most satisfactory transportation.

I was pleased that there is the chance we may get together about the smoke idea. I still seems to me that it is worth exploring. Let me know when you have made the calculations and are free for a meeting.

The report I promised you is now in preparation and I hope to send it off to you very soon.

Very truly yours,  
ARTHUR D. LITTLE, INC.

By

Bernard Vonnegut

/jr

# AIR POLLUTION FOUNDATION

704 SOUTH SPRING STREET  
LOS ANGELES 14, CALIFORNIA--  
Tel.: MAdison 6-9441

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President and Managing Director

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APR 15 8 51 AM 1955  
April 13, 1955

REFER 1  
TO 2  
FILE

Dr. Bernard Vonnegut  
A. D. Little Company  
30 Memorial Drive - Kendall Square  
Cambridge 42, Massachusetts

Dear Dr. Vonnegut:

Thank you for your letter of April 8 containing information about the General Electric nuclei meter. I think we should follow your suggestion to acquire one of these General Electric nuclei meters instead of attempting to put yours into operation, especially since you indicate that your apparatus will be needed for your work shortly.

Because our main reason for asking you to come here was to put the condensation nuclei meter into operation, it will not be necessary to impose on you to make the trip. We should have liked you to attend our informal conference on aerosols, but of course this can not be considered essential.

Perhaps sometime in the not-too-distant future, we can spend some time together discussing the smoke idea and other problems. For the present, I have been too busy with other aspects to do any more calculations on it.

We shall ship your instrument back to you in the near future. Please let us know if there are any special shipping instructions.

Yours truly,

*M. Neiburger*  
M. Neiburger  
Senior Meteorologist



April 8, 1955

Dr. M. Neiburger  
Senior Meteorologist  
Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California

Dear Dr. Neiburger:

59230

I am sorry that I am this late in replying to your letter of February 18 concerning my proposed trip to Los Angeles to put the nuclei meter into operation. My plans have been quite up in the air because of the Dublin meeting; however, it is now definite that I won't be going. Because of this change in plans I will now be able to come to Los Angeles on April 22 without being rushed.

I continue to feel that it is highly desirable that you make condensation nuclei measurements. These nuclei may play a significant role in the formation of the much larger smog particles. Also, I believe that condensation nuclei may be useful for tracing contamination.

Although I believe it is desirable that you measure nuclei concentration, there is now a big question in my mind whether it is desirable that you use our apparatus and that I make a trip to get it going. Since my last letter to you I have found that a commercial nuclei measuring apparatus is now being sold by General Electric. This apparatus is based on my original instrument which you have, and undoubtedly has many improvements. This device sells for about \$650 and probably you could have one of your own for little more than the cost of my trip. It is my feeling that the wisest course of action for you would be to buy one of these instruments and try it out for yourself. If you desired more identical pieces of apparatus these could be readily secured. This would certainly not be the case with my unique and rather bulky device. I am enclosing a copy of G.E.'s information sheet on their device.

Another reason that it appears desirable to me that you have nuclei measuring apparatus of your own is the fact that the apparatus we sent to you is the property of the Signal Corps and will probably be required in work that we are doing. At the time I sent it to you I had not anticipated that such a long time would elapse before it was put into operation. I hesitate to have you

Dr. M. Neiburger  
Air Pollution Foundation

-2-

April 8, 1955

begin work with this device when it is problematical how long it will be available for your use.

It was not entirely clear to me from your letters whether there are specific reasons other than the nuclei meter that you would like me to come to Los Angeles. If the calculations regarding the light absorbing smoke have been made and you would like to proceed further or if there are other things I might do I will be glad to come. If not, and if you agree that it is best that you procure your own nuclei meter, I feel that it would be difficult to justify my trip. Please let me know your feelings on this.

I had not realized until I received your letter that Dr. Hitchcock would like to have a report on the work that I did with you. I am accordingly preparing a report for you which should be completed in a week or two.

Very truly yours,

ARTHUR D. LITTLE, INC.

By

*BV jr*

Bernard Vonnegut

/jr  
Enclosure

Summary of Opinion Survey on  
MANAGEMENT POLICY AND AIR POLLUTION

March 15, 1955

In the course of preparing a study of management attitudes toward air pollution problems, Pendray & Company, New York public relations counseling firm, surveyed 177 major corporations in January, 1955.

All these companies were leaders in their particular branches of industry, and all were likely to have had air pollution problems because of the nature of their operating processes. Responses were received from 51 per cent of those surveyed.

Major conclusions of the survey are these:

1. Public opinion determines the pace of industry's attack on air pollution. Top management classifies air pollution as a major public relations problem.
2. The great majority of business executives feel they have improved the air pollution situation in their communities during the last five years and that business spending in this field is on the downgrade. However, the 20 firms that described specific plans will spend alone a total of \$52,730,000 in the next five years.
3. However, almost half of them feel there is need for additional encouragement, in the form of changes in the Federal income tax law such as accelerated amortization,

etc., to get business to do more about air pollution control.

4. Although concern was expressed that local communities sometimes force companies into expensive and unreasonable action, there is vigorous opposition to any additional Federal or state activity.
5. Many contend that industry has done its share of "cleaning up," but that other causes, such as private dwellings and automobiles, are now primarily responsible for air pollution.
6. While a majority report a need for more research into causes and cures, the respondents divided almost evenly on the need for a unified national research program or other industry cooperation in this field.

The tabulation of answers to specific questions by percentages follows:

1. In general, do you believe the air pollution situation in the communities where your company has operations is getting better, is about the same, or has become worse in the last five years?

|                          |             |
|--------------------------|-------------|
| Getting better. . . . .  | 72 per cent |
| About the same . . . . . | 20 per cent |
| Worse . . . . .          | 1 per cent  |
| No answer . . . . .      | 7 per cent  |

An executive of the Standard Oil Company of Ohio made this comment: "Statistics show the situation is better. However, the public is more sensitive to air pollution, so an opinion poll would probably be in disagreement with the facts."

2. Nationally, what do you feel is principally causing air pollution? (Most respondents indicated more than one source)

|                             |             |
|-----------------------------|-------------|
| Industry . . . . .          | 57 per cent |
| Private dwellings . . . . . | 51 per cent |
| Vehicles . . . . .          | 39 per cent |
| Others . . . . .            | 12 per cent |
| No answer . . . . .         | 12 per cent |

Many respondents cited the Stanford Research Institute report on causes of smog as support of their answer that industry is not alone to blame.

3. In the last five years (since 1949), how much money has your company spent on control of air pollution, approximately?

|  |             |
|--|-------------|
| Expenditures reported<br>(ranged from \$1,700 to<br>\$20,000,000). . . . . | 69 per cent |
| No expenditure . . . . .   | 5 per cent  |
| No answer . . . . .  | 26 per cent |

4. What percentage of your company's total construction costs in the last five years was for air pollution control?

|   |             |
|---|-------------|
| Specific figure<br>(averaged 5.44%) . . . . . | 45 per cent |
| No answer . . . . .                           | 55 per cent |

This percentage figure varied from less than 1 per cent for the Ford Motor Company, although it spent \$8,500,000 for pollution control, to 5 per cent or \$4,200,000 for the Socony-Vacuum Oil Company and 10 per cent or \$20,000,000 of actual plant construction for Consolidated Edison Company of New York.

5. Do you feel that you have solved your company's air pollution problem?

Completely solved . . . 35 per cent  
Almost solved . . . . . 30 per cent  
Not solved . . . . . 20 per cent  
No problem exists . . . . 9 per cent  
No answer . . . . . 6 per cent

The attitude of many was summed up by this observation of a chemical firm executive: "As our company expands we will face new problems."

6. What expenditure is planned for the next five years?

Specific figure (ranged from \$50,000 to \$15,000,000) . . . . . 27 per cent  
None or very little . . . 9 per cent  
No answer . . . . . 64 per cent

The 20 companies who were able to specify dollar estimates reported planned expenditures of \$52,730,000 during the next five years. An equal number of companies indicated reasonably large expenditures. Only a few answered that there would be no need for air pollution control spending.

The indefinite outlook for the future was emphasized by an oil company executive who commented: "Our only sounding board is the public. We will endeavor to keep ahead of their changing needs."

7. When new construction is planned in your company, to what extent is control of air pollution given consideration?

Major consideration. . . 74 per cent  
Not a problem . . . . . 8 per cent  
Moderate . . . . . 1 per cent  
No answer . . . . . 17 per cent

8. Has your company been able to recover any (or all) of the costs of control equipment or maintenance such as by capture of valuable products, etc.?

All costs recovered . . . 3 per cent  
 Some costs recovered . . 42 per cent  
 No costs recovered . . . 40 per cent  
 No answer . . . . . 15 per cent

The comment on this question by Alexander M. Beebee, President of Rochester Gas and Electric Corp., was typical: "I am frank in saying that we have not been able to recover any of the costs of this improvement through the sale of by-products...We do benefit from the greatly improved customer relationships and general good will of the people we are serving."

9. Do you feel that there is a need for an intensified national research program to discover the causes and cures for air pollution?

Yes . . . . . 45 per cent  
 No . . . . . 47 per cent  
 Perhaps . . . . . 1 per cent  
 No answer . . . . . 7 per cent

10. If so, do you feel that the Federal Government should undertake this or should industry pool its resources to do it?

Industry alone . . . . . 59 per cent  
 Industry with Federal Government . . . . . 9 per cent  
 Industry with state or local government . . . . . 8 per cent  
 Federal Government alone . . . . . 4 per cent  
 No answer . . . . . 20 per cent

An executive of an oil company commented: "Geographic, meteorological, and other pertinent conditions vary so much that Federal Government work would be a waste of taxpayers' money."

Another viewpoint was expressed by an official of the Lincoln Foundry Corp.: "The Federal Government is in too many state problems already. I think the states should appropriate funds for scientific research on the problem along with industry."

11. Do you feel that there is a need for uniform air pollution control regulations throughout the nation?

Yes . . . . . 26 per cent

No . . . . . 68 per cent

No answer . . . . . 6 per cent

12. Changes in the Federal income tax law to encourage corporations to spend for control of air pollution have been suggested.

Do you favor such action?

Yes . . . . . 47 per cent

No . . . . . 29 per cent

Perhaps . . . . . 2 per cent

No answer . . . . . 22 per cent





# AIR POLLUTION FOUNDATION newsletter

PUBLISHED BY THE AIR POLLUTION FOUNDATION  
FOR ITS OFFICERS, TRUSTEES AND CONTRIBUTORS

NOT  
A PRESS  
RELEASE

Burt Leiper, Editor

704 South Spring Street, Los Angeles 14

MAdison 6-9441

*Dr. Vonnegut*

Vol. 1, No. 6  
Feb. 24, 1955

## WHAT'S NEW SINCE LAST ISSUE

Dr. Hitchcock defines the goal for 1955. (Page 2)

Foundation puts public information program into high gear in drive to take the full smog story to the people of the Los Angeles Basin. (Page 3)

Three new trustees named to APF board. (Page 5)

Executive committee created by Board of Trustees. (Page 5)

American Meteorological Society hits Blewett Report. (Page 6)

San Francisco warned of smoggier days to come. (Page 7)

Houdry catalytic converter being tested by Foundation at Southwest Research Institute, San Antonio, Texas. (Page 8)

A private, nonprofit research foundation — Financed by public-spirited citizens —  
Dedicated to the solution of the smog problem

THE GOAL FOR 1955

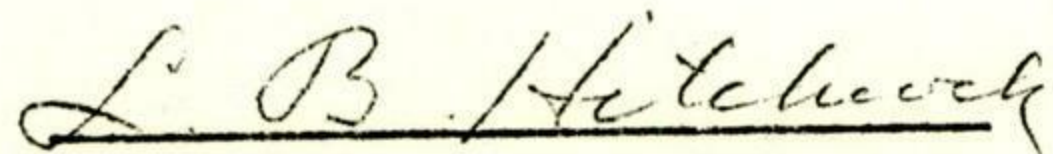
We -- the Foundation, the District, the entire community need to intensify our attack against smog. Now that the battle lines are more clearly drawn, our rate of progress will depend on the amount of troops and ammunition we throw into the battle. Undoubtedly, there is a limit beyond which additional power would be unproductive, but we are a long way short of that today. In other words, this community with its tremendous industry and population, with the help of strengthened private and public agencies, can direct their efforts with more confidence now that such effort will be productive.

The Foundation's own research program for 1955 was approved at \$1,600,000, subject to availability of funds. This limitation has enabled us to commit ourselves for research contracts only to a total of \$651,000 as of January 1. In other words, there is important needed research waiting to be started right now, requiring funds of \$1,000,000.

The largest and perhaps most important job which faces us in 1955 -- meaning by us, this whole community -- is to secure more information about the daily variation of smog over the Basin and where it comes from, in order to show more conclusively than is possible at present where added controls would produce immediate benefits. In other words, "monitoring" is essential to our continued progress. Incidentally, without monitoring, we will have no measure of the success of our combined efforts as we go along.

This major job, our 1955 Aerometric Survey, is directed entirely at our local air pollution problem and is due basically to our local peculiarities of topography and meteorology. For that reason we feel it is a job which the county, and the community it represents, should support.

We are reporting this condition to this community, because we believe you will wish to help to expedite the solution.



L. B. Hitchcock,  
President and Managing Director

FOUNDATION GETS UNDER WAY WITH BROAD PUBLIC INFORMATION PROGRAM

The Air Pollution Foundation this month shifted into high gear in its program of bringing to the public the full story of what the smog problem really is and what is being done about it.

Since its creation, the Foundation has followed a policy of doing first things first. This policy required scientific reviewing of all that had been done in the field by predecessors, and launching of new research projects to learn the answers to the many mysteries about air pollution.

However, as Dr. Lauren B. Hitchcock recalled in his President's Report last November, Objective No. 1 in the Foundation's list of seven original intentions was "to assemble a competent technical staff to organize and direct a broad program of cooperation, research and public information," and Objective No. 7 was "to publish current information by the most appropriate means on all phases of air pollution and its abatement."

Obviously, the technical work had to be launched with sure and firm hands first, but Dr. Hitchcock in that report drew a sketch of what was soon to follow when he said, "We believe we are now close to the time when we can help in a sound public information program."

As he has commented to numerous audiences since, "we have been doing our scientific job, but up until now we have been unable to deal with the equally important matter of human relations."

What Does The Public Want To Know?

An expanded public information staff has tested public opinion and satisfied itself that it now knows what the public wants to know.

Accordingly, an all-out drive has been started to:

1. Acquaint the public with the Foundation itself -- why it was created; who created it; why its creators felt an independent, nonprofit scientific research organization was necessary; who its contributors are; what the Foundation already has accomplished, and what it hopes to accomplish on both the short range and long range.
2. Acquaint the public with what other organizations, both private and public, have done and are doing toward smog abatement.
3. Acquaint the public with the reasons why research is necessary and why research takes time -- and why the public has everything to gain by being patient during the time that carefully thought out and carefully conducted research will take, and has everything to lose by being impatient and demanding "action first and thinking later."

Cooperation has been sought and is being pledged and activated by the traditional media of communication with the public -- press, radio and TV. The first chapter of a documentary movie has been completed, and additional chapters are being planned. A community action program is aimed at a fresh air information program stretching from San Fernando Valley to Orange County, from San Gabriel Valley to Palos Verdes.

### The Press Wants To Help

On February 10, the trustees were host to the publishers and editorial executives of the Times, Examiner, Herald & Express, Mirror & Daily News and Citizen-News at luncheon at the Biltmore. Dr. Hitchcock explained the problems with which the Foundation is confronted in getting its message across to newspaper readers.

The next day, Dr. Hitchcock, assisted by Dr. W. L. Faith, APF deputy director and chief engineer, met the publishers and editors of the Los Angeles Basin's other papers, the correspondents for technical journals and radio and TV executives and newscasters, at luncheon at the Ambassador.

Both meetings were greeted enthusiastically by the guests, who during question-and-answer periods made clear that they are anxious to learn the facts themselves and anxious to assist in informing their own audiences.

### Radio And Television On The APF Agenda

Radio and TV stations, too, are dedicated to the cause of informing the public, and will welcome all aid that the Foundation can give them in gathering the facts.

The Foundation is planning programs and spot announcements for these two media of communication to the public.

(As one example of the splendid cooperation we have been getting, perhaps you saw the shows the evening of February 17, on the Foundation-sponsored tests of the Houdry exhaust muffler -- KABC, KRCA and KHJ-TV.)

### The Community Action Program

Community action means taking the Foundation's message out into the many individual cities and unincorporated communities of the sprawling Los Angeles Basin.

The Foundation, recognizing that one of the best means of accomplishing this objective is through a speaker's bureau, is aiming at service clubs, PTA's, women's organizations, church groups, chambers of commerce, etc.

Trained speakers are being obtained from Foundation contributors who have had years of experience in conveying their own companies' messages to the public.

They will be supplied with information kits to aid them in telling the full smog story.

The kits will contain concrete, specific suggestions which can be adopted by John Q. Public, his wife and his neighbor, in helping to reduce smog while scientists continue their research into the causes of air pollution and their hunt for new remedies. The suggestions will include tips on care of the family automobile and proper methods of backyard burning -- burning methods to be followed until a county-wide system of trash pickup and disposal is installed to end the evil of incinerators.

The kits also will contain well defined steps which can be taken by industrial plants during the same waiting period, while scientists are developing new answers to the smog problem. These recommended steps will be in conformity with rules and regulations enacted by the Los Angeles County Air Pollution Control District.

### Short Range vs. Long Range

Is it possible to have two aims -- one short range, and the other long range -- and work on both at the same time?

The Foundation feels that nothing is impossible in the battle against air pollution and smog. First, we intend to establish once and for all in the public mind the Foundation's own unique identity, and second to paint the full smog picture in such sharp outline and discernable colors that it cannot be mistaken by this expanding community.

This is the goal of the Foundation's public information program.

### THREE NEW TRUSTEES APPOINTED TO FOUNDATION BOARD

Three new members have been named to the APF Board of Trustees since the last NEWSLETTER. They are:

J. L. Atwood, president of North American Aviation, Inc.; Garner A. Beckett, president of Riverside Cement Co., and D. J. Russell, president of the Southern Pacific Company.

Elections took place at the Board's meeting February 3.

Atwood joined North American in 1934 as chief engineer and has served in various executive capacities since that time, being elected president in 1948. He lives at 201 Chadbourne Avenue, Los Angeles.

Beckett has held executive positions with Riverside Cement Company since 1921 and was named president in 1936. He lives at 706 N. Elm Drive, Beverly Hills.

Russell lives in San Francisco. His railroad career began in 1920 when he joined Southern Pacific in the engineering department. He has held numerous executive positions since 1934, chiefly in the company's main office at San Francisco but including two years as superintendent of the Los Angeles division. He has served as president since January 1, 1952.

Selection of the three new trustees was the first step under the recently adopted policy to enlarge the board from 21 members to 35, in order to obtain wider representation as the Foundation broadens its scope.

The 11 additional trustees, to be named in the near future, will include outstanding men in the fields of business, industry, science and education from Northern California and other sections of the nation -- in line with the Foundation's expanding program of scientific research into the causes of air pollution.

### APF EXECUTIVE COMMITTEE FORMED

The Board of Trustees at its February 3 meeting approved the formation of a 9-member Executive Committee to expedite the steadily increasing work load of the board.

Trustees named to the committee were:

Dr. Raymond B. Allen, chancellor, University of California at Los Angeles, (Foundation chairman); Dr. Arnold O. Beckman, president, Beckman Instruments, Inc., (vice-chairman); James E. Shelton, president, Security-First National Bank, (treasurer.)

F. M. Banks, president, Southern California Gas Co., (public relations committee chairman); Dr. Lee A. DuBridge, president, California Institute of Technology, (research committee chairman); A. J. Gock, former chairman of the board, Bank of America, (finance committee chairman.)

Asa V. Call, president, Pacific Mutual Life Insurance Co.; Reese H. Taylor, president, Union Oil Company of California, and Fred B. Ortman, chairman of the board and president, Gladding, McBean & Co.

Dr. Lauren B. Hitchcock, president and managing director of the Foundation, will serve as an ex-officio member, and LeRoy A. Garrett, secretary to the board, will serve as committee secretary.

#### AMERICAN METEOROLOGICAL SOCIETY HITS BLEWETT THEORY

The president of the American Meteorological Society last month provided independent support of the Air Pollution Foundation's finding that the so-called "Blewett theory" is invalid.

Since the AMS is the national organization of meteorologists of the country, the Foundation forwarded to the Los Angeles County Board of Supervisors the full statement by the AMS president, A. F. Merewether.

Merewether's statement reached the Foundation in the form of a carbon copy of a letter he had sent from his New York headquarters to the West Coast magazine which first publicized the Blewett statement. He sent a copy to Dr. Morris Neiburger, our senior meteorologist, with permission for the Foundation to use it as the Foundation might see fit.

(Only a few days earlier, the Foundation, in reply to a formal request by the Board of Supervisors, had filed its analysis of Stephen E. Blewett's theory. The Foundation pointed out that scientific evidence shows that smog is man-made -- not a natural phenomenon, as contended by Blewett.)

Merewether said in his letter:

"I do not agree with the basic tenets of the Blewett report, that ozone and nitrous dioxide brought down from the stratosphere or off the Pacific Ocean are the cause of your smog, rather than man-made contaminants produced under an almost ideal weather and geographical setup. Air pollution is usually the result of a favorable weather condition of little wind and a low inversion, plus the introduction into the atmosphere of contaminants, such as industrial pollution, smoke, etc. The inversion acts as an impenetrable lid on top. The earth's surface prevents escape from below. If to these conditions there is added a barrier on the sides in the form of a range of mountains open only to a light wind bringing in moist air over a cool ocean, then you have the perfect setup.

"Since Los Angeles has all these, plus a highly industrialized population of some 5,000,000 people, daily pouring tremendous quantities of contaminants into this air trap, it is not at all surprising that conditions are as bad as they are."

SAN FRANCISCO WARNED OF SMOGGIER DAYS TO COME

As the San Francisco Bay Area continues to grow, its air pollution can be expected to "reach increasing levels of intolerability more and more frequently."

This warning was sounded by Dr. Lauren B. Hitchcock, February 21, at a State-wide Conference on Air Pollution Legislation conducted at San Francisco by the California State Chamber of Commerce.

"There seems little doubt from all preliminary reports that the Bay Area air pollution problem already exists, so far as can be estimated, very much like the Los Angeles problem about five years ago," the Foundation chief said.

Dr. Hitchcock emphasized that the Foundation is prepared to make its own findings available to all areas of the state which might request help in combating a growing smog problem, explaining:

"The cost of air pollution research is substantial, and duplication should be avoided so far as possible in the interest of both money and manpower.

"The job for which the Air Pollution Foundation was created does not have to be done over and over."

He recommended that the State support air pollution research through existing agencies, rather than creating new ones, and that a committee be appointed to study and recommend how air pollution fact-finding efforts in the State could best be co-ordinated. The conference voted overwhelmingly in support of both proposals.

REPORT NO. 3 OFF THE PRESS

The Foundation's scientific Report No. 3, covering the recent conference on incineration, rubbish disposal and air pollution, is now off the press. Copies have been sent to trustees, contributors and county and municipal officials. Additional copies are available at \$3 each.

Chief Administrative Officer Arthur J. Will, Los Angeles County, distributed copies to members of a countywide conference called to consider ways and means of expediting collection and burial of rubbish and exiling of incinerators.

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Also now available -- result of a second printing required by an unanticipated demand -- are copies of Report No. 2 on combustion.

Meanwhile, a second printing will be started within the next few days on Report No. 1, covering meteorology of the Basin. This report has been out of print since last July.

HOUDRY CONVERTER BEING TESTED

Newspapers, radio, TV and automotive and technical magazines have been showing a marked interest in the road tests arranged by the Foundation for the Houdry catalytic converter.

The muffler, designed by Eugene J. Houdry, who invented the catalytic cracking process for gasoline, is believed to be one of the most likely prospects for reducing hydrocarbon emissions for auto exhausts.

The tests were started this month at Southwest Research Institute, San Antonio, Texas.

Two mufflers for white gasoline are being tested on 1954 Power-Glide Chevrolets, and four for leaded gasoline are being used on a 1954 Ford V-8, a 1954 DeSoto V-8, a 1953 Buick and a 1953 Cadillac.

Each of the six Houdry-equipped autos are being subjected to 20,000-mile road tests simulating Los Angeles Basin driving conditions. At the end of each 1,000 miles, checkups are being made to determine whether the catalytic units still are functioning properly and what effects are discernable on the auto's engine.

SOMETIMES IT PAYS TO GET UP IN THE MORNING

The correspondent is Dr. S. S. Negus, chairman of the department of biochemistry, Medical College of Virginia, and director of public information for the American Association for the Advancement of Science.

His letter to the editor: "Hardly anybody takes time nowadays to commend anybody else for anything. This morning I feel like being unusual so want to congratulate you on the splendid job you are doing in editing the Air Pollution Foundation Newsletter. It is exceptionally newsworthy, well written and mimeographed neatly. I had to commend somebody this morning and you are the only one I could think of - other than my secretary who writes very neat letters."

Burt Leiper and Don Kirby, co-editors, thank S. S. Negus and his secretary for their neat commendation.

CONGRESSIONAL INTEREST IN SMOG GROWING

Russell S. McBride, the Foundation's Washington representative, this week sent copies of 14 new Congressional bills on air pollution to APF headquarters. Most of the new bills deal with providing a shorter amortization period for business firms installing control equipment, whereas most earlier bills dealt with proposals for federal research.

ELECTRICAL ENGINEERS GET SMOG LOW-DOWN

Members of the American Institute of Electrical Engineers (Basic Sciences Division) heard Dr. Hitchcock and Dr. Renzetti discuss "Smog from the Scientific Standpoint" at a meeting last February 3 at the University of Southern California.



Dr. Hitchcock described what the Foundation is measuring in the atmosphere and why, and Dr. Renzetti explained how the measurements are made.

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On January 26, Dr. Hitchcock spoke before the Los Angeles Downtown Kiwanis Club. His topic was "Air Pollution -- A Community Problem." Simultaneously, Burt Leiper, APF Public Information Officer, was addressing the Los Angeles chapter of the Public Relations Society of America on "Building Public Understanding About the Smog Problem."

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"Smog -- Whose Problem?" was the title of an address delivered by Dr. Hitchcock, February 9, to the Southern California Council of the State Chamber of Commerce at the Biltmore February 9.

#### TECHNICAL PROGRESS REPORT UPCOMING

Trustees and contributors were treated February 15 to an oral preview of the Foundation's forthcoming First Technical Progress Report at the Bank of America Building, Seventh and Flower Streets.

An audience of approximately 100 heard reports by the Foundation's team of scientists -- Dr. Lauren B. Hitchcock, Dr. W. L. Faith, Dr. Lewis H. Rogers, Dr. Nicholas A. Renzetti and Dr. Morris Neiburger, and saw the first section of the Foundation's new documentary sound film.

The report, in printed form, will be available within the next few weeks and will be mailed to all trustees and contributors. Copies will be sent also to scientists, editors and others interested in the smog abatement problem.

At the February 15 meeting, the Foundation team summarized the various sections of the full report, illustrating the points with pictures and data on slides.

#### OTHER COMING EVENTS

In preparation are two important Foundation documents -- Report No. 4 (Technical Progress Report) and Report No. 5 (hydrocarbon losses from the Petroleum industry in the Los Angeles Basin).

On Thursday, March 10, Dr. Hitchcock will be the speaker at the annual inspection and review of the U. S. Naval Air Reserve Training Unit at Santa Ana. Rear Admiral D. V. Gallery, chief of naval air reserve training, will inspect the complement of Commander A. L. MacCubbin, who recently became skipper of the Santa Ana lighter-than-airship training unit.

R. Stevens  
cc: H.C. McMahon  
C. Moore

59280

February 23, 1955

1

Southern California Air Pollution Foundation

This summary is intended to give a brief picture of the status of our relations with the S. Cal. Air Pollution Foundation. Briefly, the situation is this. Last October 4 and 5, I visited with Dr. Hitchcock and his staff and discussed matters as outlined in the enclosed memo written at that time. I particularly recommended that experiments be carried out in Los Angeles to determine the behavior of black smoke under their prevailing meteorological conditions. Dr. Hitchcock was reluctant to carry out these experiments and suggested that before doing anything, he would like to have Dr. Neiburger make further calculations to examine the idea more closely. Because I realized that Dr. Neiburger has heavy demands on his time, I offered the alternative idea that perhaps, if they liked, I could have Prof. Houghton of MIT make the calculations. This suggestion was in no wise intended to suggest that Dr. Neiburger was not thoroughly competent to do the job but it was so interpreted by Dr. Hitchcock. I explained that this was certainly not the intent of my remarks. After this incident was smoothed over I left with the assurance that Dr. Neiburger would make the calculations and that I would hear from him.

Since that time I have written several letters urging that the experiment be carried out and expressing interest in the status of the calculations. I have received no reply to these letters except a recent note from Dr. Neiburger saying that the calculations haven't been done and that he would like to have me visit in April.

Attached to this memo are copies of our exchange of correspondence with the Air Pollution Foundation. I think these letters give a pretty good summary of the present situation. It appears to me that thus far the Foundation has failed to act on any of my suggestions and that there is little that can be accomplished by further letters to them. I plan to visit them in April as Dr. Neiburger suggests. I hope that by then he will have made the calculations and that we may be able to proceed with some sort of experimental program involving black smoke and other ideas that I have proposed to them.

*BV jr*

Bernard Vonnegut

B. Vonnegut

**AIR POLLUTION FOUNDATION**

704 SOUTH SPRING STREET  
LOS ANGELES 14, CALIFORNIA

Tel.: MAdison 6-9441

February 17, 1955

DR. D. LITTLE INC  
ACTION \_\_\_\_\_  
DATE AHS. \_\_\_\_\_ BY \_\_\_\_\_

FEB 19 10 38 AM 1955

LAUREN B. HITCHCOCK  
President and Managing Director

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- P. G. WINNETT

•  
LEROY A. GARRETT  
Secretary of the  
Foundation

Dr. Bernard Vonnegut  
Arthur D. Little, Inc.  
Memorial Drive at Kendall Square  
Cambridge 42, Massachusetts

Dear Dr. Vonnegut:

C-59280

*Copies sent to  
Central Sales*

You are correct that the arrangements made between Dr. Hitchcock and your company were for you to serve as consultant to the Air Pollution Foundation only until the end of last year. I was not aware of this when I wrote you. Dr. Hitchcock has agreed to an arrangement whereby you would be reimbursed for your travel expenses and per diem consulting fee for two days, to attend our conference on aerosols on April 21st and to spend one day in setting up and testing the nucleus counter. Since we shall be tied up with the Third National Air Pollution Symposium on the days previous to the 21st, we should prefer that the day you spend setting up the nucleus counter be April 22nd.

Ordinarily the periods of severe smog do not start until after the first of July, so that getting the nucleus counter in operation by the end of April should give at least two months of smog free records before the concentration increases greatly.

In discussing these matters with Dr. Hitchcock, he mentioned that he had expected to receive a report on the six months' work which was done under the arrangement between you and the Foundation. Would it be possible for you to prepare such a report?

I realize that your being here on April 21st and April 22nd makes for a tight schedule in arriving in Dublin by April 26th. Please let me know whether you think you can make it.

ORIGINAL TO: B. Vonnegut  
COPIES SENT TO: R. Stevens  
(1) R.S. Robinson (2) J. Stoue  
E. Claussen, Vault

MN:1K

Yours very truly,

*M. Neiburger*  
M. Neiburger  
Senior Meteorologist

February 1, 1955

Dr. M. Neiburger, Senior Meteorologist  
Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California

Dear Dr. Neiburger:

59280

Thank you for your recent letter of January 21 concerning the condensation nuclei meter. I will be glad to come to Los Angeles in April as you suggest to set up the nuclei meter and to attend the Third National Air Pollution Symposium.

You mention staying after the Symposium for a few days to set up the nuclei meter. I wonder if it would be equally satisfactory if I came a few days early instead? I plan to give a paper at the "Symposium on Condensation Nuclei" to be held in Dublin April 26 and this would give me a little more time to make connections.

I believe that the arrangements that were made between Dr. Hitchcock and our company for me to serve as a consultant to the Air Pollution Foundation lasted only until the first of this year. I presume that this arrangement can be extended to cover my visit in April. You might bring this to Dr. Hitchcock's attention.

I will be eager to learn the results of your computation on the black smoke. I still believe that this may be a useful technique for conducting some contaminants to higher levels and perhaps causing them to rise through the inversion. From his letter to Mr. Stevens of our company I gather that Dr. Hitchcock is under the impression that I have abandoned this idea or feel that it should be pursued no further. Such is certainly not the case and I must have expressed myself very poorly to have given this idea.

I feel, and I believe Dr. Langmuir agrees, that it is well worth running some experiments to see how the black smoke behaves under the very stable conditions in Los Angeles that cause smog. These experiments should not be too difficult or expensive and should give us some idea of what might be accomplished.

Dr. M. Neiburger  
Air Pollution Foundation

-2-

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February 1, 1955

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To return to the nuclei meter, I think it is desirable that we have this apparatus in operation for a while before the smog season begins. It will be of interest to contrast the records in summer and winter. Do you think that April will give us enough of the smog free season for contrast?

Very truly yours,

ARTHUR D. LITTLE, INC.

By

Bernard Vonnegut

/jr

December 8, 1954

Mr. Robert S. Weatherly  
Assistant Treasurer  
Southern California Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California

Dear Mr. Weatherly:

59280

In reply to your letter of November 30, the approximate cost of the Condensation Nuclei Counter that we have loaned to the Southern California Air Pollution Foundation is \$1000.

Very truly yours,

ARTHUR D. LITTLE, INC.

By

Bernard Vonnegut

/jr

# SOUTHERN CALIFORNIA AIR POLLUTION FOUNDATION

704 SOUTH SPRING STREET  
LOS ANGELES 14, CALIFORNIA  
Tel.: MAdison 6-9441

LAUREN B. HITCHCOCK  
President and Managing Director

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P. G. WINNETT

•  
LEROY A. GARRETT  
Secretary of the  
Foundation

December 3, 1954

Gentlemen:

The Southern California Air Pollution Foundation presents you with a complimentary copy of its technical Report No. 2, "Combustion and Smog," by Dr. W. L. Faith, Deputy Director and Chief Engineer for the Foundation.

This report critically examines and summarizes the current published data on the relation of combustion processes and their effluents to smog. The areas of disagreement are indicated.

We believe you will find this report of further interest because every home, every motor vehicle, the power plants, heating plants, and industrial processors (all of these) contribute to the emissions from combustion.

We are presenting you with this copy because of your interest in the air pollution problem. Additional copies are available in limited quantity at our cost of \$3.00 each.

Sincerely yours,

*L. B. Hitchcock*  
Lauren B. Hitchcock

LBH:g

November 26, 1954

Dr. Lauren B. Hitchcock, President  
Southern California Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California

Dear Dr. Hitchcock:

59280

Several days ago, when I returned from a brief vacation, I was pleased to receive a copy of Dr. Langmuir's remarks concerning his ideas on smog prevention. I hope that you found his ideas helpful and that he will be able to make further contributions when he visits you in a few months.

Appropos of Dr. Langmuir's comments, I feel that I should explain that I do not believe that the black smoke technique will be able to wipe out inversions. However, I do believe that it may be possible to confine the contaminants to a thin layer beneath the inversion base and perhaps even carry them through it.

I continue to be very much interested in the possible effects of the smog on the solar heating in the Los Angeles basin. We have available here climatological data containing solar radiation measurements made by the U.S. Weather Bureau and we have prepared the enclosed graph showing the relation between the monthly average of the daily solar radiation at station Riverside and Los Angeles WBAS. It appears possible that the shaded area, during the summer months, indicating a deficit in solar radiation at Los Angeles, may be the result of smog. Perhaps you now have more detailed information on the relation of smog to solar heating.

We have finally been able to put our condensation nuclei meter back in working condition and have shipped it to you. I believe that it is probably best to wait until my next visit before attempting to put it into operation. However, my first report on this apparatus in the "First National Air Pollution Symposium" contains enough information so that if



Dr. Lauren B. Hitchcock  
Southern California Air Pollution Foundation

-2-

November 26, 1954

any of your staff want to try it, they should be able to get it going. I hope that this instrument may prove useful in monitoring the concentration of condensation nuclei, which is certainly an important variable in atmospheric pollution.

If you would like to have me come to Los Angeles to put the nuclei meter in operation as soon as it arrives, I will be glad to make the trip. However, I feel that it might be well to postpone my next visit until Drs. Neiburger and Renzetti have completed their calculations on the black smoke idea.

Very truly yours,

ARTHUR D. LITTLE, INC.

By

Bernard Vonnegut

/jr  
Enclosure

SOUTHERN CALIFORNIA AIR POLLUTION FOUNDATION  
704 SOUTH SPRING STREET  
BURT LEIPER

ROOM 810  
MA - 6-9441

HOLD FOR RELEASE  
TUESDAY, NOV. 16, 1954  
1:30 P.M.

FOUNDATION CHIEF  
URGES FUNDS FOR  
'TOLERABLE AIR'

Hitchcock Says Temporizing,  
Shortcuts Spell Failure;  
Asks All-Out, United Front  
In First Annual Report

ARTHUR D. LITTLE, INC. w  
DATE NOV 18 1954  
ACTION \_\_\_\_\_  
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DATE ANS. \_\_\_\_\_  
ANS. BY \_\_\_\_\_  
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TO 2. \_\_\_\_\_

"Free as air" may be a household phrase, but it is out of date, Dr. Lauren

B. Hitchcock said today as he made his first annual Progress Report as President and Managing Director of the Southern California Air Pollution Foundation.

"The air is no longer free in the Los Angeles Basin. The supply is limited," he told contributors, founders, and trustees for the Foundation who attended the Foundation's first birthday luncheon at the Ambassador Hotel.

"How much is tolerable air worth to people in the Basin?" he asked.

Proposing a research program for 1955 which would cost an estimated \$1,800,000, the Foundation leader cautioned that the eventual cost may be comparable to other indispensable services, such as potable water, the sewage system, the harbor, and the freeways.

He placed the responsibility for tolerable air at the doors of industry and the public itself. The auto industry and the oil industry, who contribute to the Foundation, were reminded of their continuing responsibility. But the contribution to smog and air pollution of industry, substantial as it is, is about one-half of that from the public itself - from its automobiles and incinerators, he said.

"We in the Foundation are here," he said, "because we believe this job can be done. But a five-man scientific team can't do it alone. The Air Pollution Control District can't do it alone. Government can't do it alone. Citizens' committees can't do it alone. The problem is still with you because you temporized, because you hoped for shortcuts - and all this spells failure."

## HITCHCOCK REPORT II

Hitchcock said the Foundation is tackling in a pioneering phase one of the biggest social problems man has yet encountered. He said the problem can be licked and a solution is possible, but not on a part-time basis.

Dr. Hitchcock said: "It became obvious to us some months ago that one of the most controversial and possibly significant sources of pollution in this Basin was the emission of hydrocarbons from our refineries. We made up our minds that an absolutely independent audit should be made. A nation-wide search by the Foundation resulted in the choice of the Southwest Research Institute of San Antonio, Texas, as a competent and impartial auditor. Under the direction of Dr. Judson Swearingen, a recognized authority who has never been in the employ of any petroleum company, a personal and physical check of all hydrocarbon losses was made in all of the major refineries in this Basin and in typical small independent refineries.

"Hundreds of samples were collected by the Institute and analyzed under their supervision. Capacities of storage tanks and characteristics of other equipment were determined independently by them. We believe our survey has been more thorough than those made by the petroleum refineries themselves."

The total hydrocarbon emission to the atmosphere as determined by the Institute was 251 tons a day as compared to the 224 tons-per-day loss reported by the Western Oil and Gas Association to the Stanford Research Institute. The difference between the losses of 251 and 224 tons is believed to be within the error to be expected from this type of estimate. Olefins, a more reactive form of hydrocarbons, included in these totals, were reported at 16.4 tons, compared with 12.2 tons reported by the Association.

The audit covered nine major and eleven independent companies in Los Angeles County. It included personal inspection of oil fields producing 52 percent of the County's output, refineries possessing 95 percent of the County's refining capacity and all bulk and marine terminals.

### HITCHCOCK REPORT III

The Institute examined plant records, interviewed technical personnel, inspected facilities and collected and analyzed samples.

The Foundation President said further that it is beginning to appear that the contribution of pollution from industry, substantial as it is, is about half the contribution of the public itself through its automobiles and incinerators.

Basing his figures on the consumption of gasoline in the Los Angeles Basin, he said: "It is a matter of simple arithmetic to calculate that unburned gasoline from the exhaust pipe contributes about 1,000 tons per day of hydrocarbons, plus about 300 tons of organic acids and aldehydes, oxides of nitrogen and sulfur.

"This is not a matter of opinion," he added. "The automotive industry recognizes the automobile as the largest single source of hydrocarbons in our atmosphere. Competent scientific evidence is mounting to show that auto exhaust gases in the concentrations found in our atmosphere are capable of forming ozone and may be considered as a definite source of smog."

Hitchcock said further confirmation is needed in order to reach substantial agreement by all concerned on the cause-and-effect relationship between these various exhaust pollutants and the formation of smog. He said this research is an important part of the Foundation's 1955 program.

The Foundation President announced a contract with Battelle Memorial Institute in Columbus, Ohio, to study the composition of emissions from backyard incinerators. The purpose is to discover what and how much is emitted by different types of operation. Present findings do not agree. A Foundation conference on incineration, rubbish disposal and air pollution will be attended by national experts in Pasadena on December 2 and 3.

Dr. Fred D. Fagg, Jr., Chairman of the Foundation's Board of Trustees and President of the University of Southern California, reviewed the history of the Foundation since 140 citizens gathered at the same hotel one year ago.

It was on November 23, 1953, that the Board held its first meeting following its incorporation as an independent, non-profit scientific organization.

Hitchcock presented a program for the coming twelve-month period which amounts to \$1,600,000 for research and totals \$1,800,000 including operating expenses.

He said it is obvious that a program of such size would be possible only if supported largely by the County and the State. The Foundation, he explained, will seek \$750,000 from its own supporters.

"We assume," he added, "that the County of Los Angeles, the State of California, with the Foundation, will find ways and means of carrying out this very necessary program."

He said that it is going to take the concentrated effort of industry, government and private agencies on a scale more comparable to wartime effort than typical peacetime civic welfare movements to develop practical, workable remedies. The Foundation, he said, is in an excellent position to catalyze this effort, contributing only so much of its own research as would stimulate and guide those who have the basic responsibility and the large resources.

"Look ahead two years -- four years -- or even six years," he cautioned. Using the Foundation's own statistical estimates, Hitchcock predicted a Basin population in 1960 of 6,200,000 persons, nearly 3,000,000 motor vehicles burning 18,000 tons of gasoline a day, 1,860,000 incinerators burning 6,200 tons of rubbish per day.

"Why go on?" the speaker asked. "How much worse does it have to get? How intolerable does our atmosphere have to get before enough people say 'this is the limit; I've had enough?' Is this community going to wait until that time comes (if it has not come already) to stop wrangling and criticizing each other, and unite behind a well-organized, large-scale attack on this problem?"

Turning to the Foundation's new and continuing program, Hitchcock said it is a minimum research plan, that anything less is temporizing a "community necessity above politics or any private interest."

If we start an all-out effort now, he continued, we may hope to have tolerable air in five years and relief perhaps sooner.

Hitchcock reported that his scientific task force was complete on May 1. In the past six months, more than thirty projects have been activated. These will have cost the Foundation about a half million dollars by the end of December. The most important of these is the Aerometric Survey, the objective of which is to sample the atmosphere at strategic points in the Basin and measure the formation, composition and movement of smog. He said many improvements have been made in the tools and methods and recommends a Summer and Fall survey for 1955, at a cost of \$ 566,550.

He said that altogether, more than 100,000 measurements will have been made in this study by December 1. Hitchcock then demonstrated with charts a part of the findings of the Aerometric survey. He selected two of the smoggiest days of the Summer and Fall, September 24 and October 14, as compared with a pleasant day, October 25. This, he said, is only "two one-hundredths of one percent of the data to be included in the entire study."

Two stations chosen for comparison were downtown and Pasadena. The inversion height on the two smoggy days was about 500 feet; on October 25, it was 6,500 feet, or thirteen times as much volume in which the air pollution could disperse.

He demonstrated that the manifestations of smog are very different in different parts of the Los Angeles Basin. Plant damage downtown, for instance, may be slight while at other stations it is severe on the same day. Oxidant values are often the same at such times. Eye irritation reports in Pasadena, even on the day of little or no smog, were heavier than those downtown. Plant damage on September 24 was nearly twice that on October 14 (Black Thursday) in the downtown

HITCHCOCK REPORT VI

Hydrocarbons have varied from close to zero up to 1.6 parts per million downtown and up to four-tenths part per million in Pasadena.

Aldehydes (oxidation product of hydrocarbon) as well as nitrogen dioxide, products of most combustion, have reached concentrations of seven-tenths part per million downtown.

SOUTHERN CALIFORNIA AIR POLLUTION FOUNDATION

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List of Contributors  
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November 10, 1954

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SOUTHERN CALIFORNIA AIR POLLUTION FOUNDATION  
704 SOUTH SPRING STREET ROOM 810  
BURT LEIPER MA - 6-9441

*H.A. Stewart*  
*2) B. Vornigut*  
HOLD FOR RELEASE DATE  
EXPECTED TUESDAY, NOV. 16, 1954  
CHECK FOR UPDATING ON LOS  
ANGELES SUPERVISORS' MEETING  
ABOVE DATE

FOUNDATION SMOG  
PROGRAM INCLUDES  
STOP-GAP MEASURES

The Southern California Air Pollution Foundation, in response to a request from Herbert C. Legg, Chairman Pro Tem of the County Board of Supervisors, has submitted a strongly reinforced and expanded research program aimed at combatting smog both on an emergency and long-range basis in 1955.

The program, submitted to the Board today (Tuesday, Nov. 16, 1954) combines highly practical research with basic research. It proposes a combination of manpower, resources and facilities of the County of Los Angeles, the Southern California Air Pollution Foundation, the State of California, and the United States Government.

Unprecedented in scope and in its over-all approach, it would cost an estimated \$2,214,400.

"We are well aware that the total estimated cost is a large figure in comparison to what has been spent before," said Dr. Hitchcock, "but the state of our knowledge has reached the point where we can realistically assess the magnitude of our problem."

The proposed program offers the study and development of stop-gap, emergency action during the coming year. It includes the continuing search for better scientific tools, clearer identification of the contributors and contaminants identified with smog in the Los Angeles Basin.

It extends important research vigorously into significant fields which are either suspect or hopefully remedial.

It includes a study of the economics and feasibility of using non-leaded (white) gasoline in a catalytic converter for the auto exhaust.

It considers the more difficult task of developing a converter for use with leaded (presently-used) gasoline. It would explore the possibility of a blend of synthetic alcohol and gasoline as automotive fuel.

The feasible use of liquefied petroleum gas, or LPG, as an alternate fuel is proposed in one project. Limiting the use of motor vehicles somewhat as in World War Two, would not be overlooked, nor would the control of so-called "smokers," that is, autos which are emitting obvious fumes.

These are samples of the stop-gap program, a program which Hitchcock explained is the result of the evaluation by the five-man scientific team in the fields of engineering, chemistry, physics and meteorology; the result of a nation-wide acquaintance with other scientists in their respective fields; the ability of the Foundation to hire and consult with the country's leading authorities; the benefit of having the counsel of local scientists and the Los Angeles County Air Pollution Control District.

Dr. Hitchcock further explains that the public "should be told frankly and honestly that we have no reason to expect any significant relief for at least five years unless, unless we get united public support behind remedies which are suggested."

He emphasized that stop-gap procedures should be given close scientific examination because of the increasing probability that more desirable ultimate solutions may take several years.

The suggested support for the program is defined broadly as follows:

|  |                    |
|--|--------------------|
| Southern California Air Pollution Foundation | \$ 702,350         |
| Los Angeles County                           | 986,550            |
| State of California                          | 435,500            |
| Federal Government                           | 90,000             |
|  | <u>\$2,214,400</u> |

The program is endorsed by the research committee of the Foundation, including Dr. Lee A. DuBridge, President of the California Institute of Technology, Chairman; Dr. Raymond B. Allen, Chancellor, University of California at Los Angeles; Mr. F. M. Banks, President, Southern California Gas Company, and Dr. Arnold O. Beckman, President, Beckman Instruments, Inc.

In a letter to Supervisor Legg, Dr. Hitchcock said: "We believe all the listed projects are important and would not wish the order of listing to be given particular significance. We have placed certain speed-up programs first because they may offer earliest possible hope of relief on important pollution sources. Certain projects are suggested as appropriate for support by the County, State, or Federal Government. Support will be welcomed from any and all sources. We have submitted this program in direct response to your request, without consideration for the moment as to where the work will be done. It is obvious that a program of this size will be possible only if supported largely by County and State. The Foundation will continue to do all it possibly can with funds it can derive from private sources."

\*\*\*\*\*

(Note: See Research Background Information Attached)

BACKGROUND FOR TWELVE-MONTH RESEARCH PROGRAM

While this is the biggest research program ever drawn up by anyone for the Los Angeles air pollution problem, it does not seek "bigness" for the sake of the word. On the basis of presently known facts and their relationship to the unknown, it could be three times as big. The expenditure of two and one-fourth million dollars represents less than one cent a week for every person in the Los Angeles Basin. The population of the Basin is more than 5,000,000 persons.

Every project is the result of careful study by our five specialists in chemistry, physics, engineering and meteorology. All available information has been assembled and evaluated. Never before has a team made such a concentrated and complete study with the sole purpose of developing at this stage a research program on smog and air pollution. This is the program with Foundation comments: (Note emphasis on words "feasibility" and "economic")

I. Feasibility & Economic Studies of 'Stop-Gap' Procedures

- a. Development of Catalytic Converter for Auto Exhaust
  - 1. Non-leaded (White) Gasoline
  - 2. Leaded Gasoline \$200,000

COMMENT: The much talked-about catalytic converter is successful on lift trucks in a warehouse, where carbon monoxide must be prevented. Now we must consider whether this can be adapted to an auto running on white gasoline; whether enough white gas can be provided without resorting to the extra boost by tetraethyl lead. We also recommend investigation of the development of a catalytic converter to work on our present leaded gasoline. The difficulties here are more complex. The stop-gap procedure is not as quick as for white gas.

- b. Development of Alternate Fuels
  - 1. Alcohol Blends \$100,000

COMMENT: We suggest looking into the development of alternate fuels. A blend of synthetic alcohol with gasoline, for instance. Alcohol is made by a number of refineries. If necessary, most could install synthetic alcohol equipment which synthesizes alcohol from hydrocarbons. It has been claimed that fifteen percent of alcohol in gasoline improves combustion. Our first job would be to test this claim, or find out if other blends make a significant difference.

- 2. LPG \$100,000

COMMENT: Liquefied petroleum gas or its equivalent was recommended in the Beckman report for trucks and buses. Evidence so far indicates LPG has a very clean exhaust. To use it on autos we would replace our carburetors with a simple injection system, with a high pressure storage tank and a high pressure fuel line to the engine. There is some apprehension about the dangers of autos carrying high-pressure cylinders. LPG is an established industry for home use. We propose investigation of the feasibility and economics of installing such a tank in the auto, surrounding it and protecting it as necessary.

RESEARCH PROGRAM II

- c. Limiting Use of Motor Vehicles \$10,000
- d. Control of Excessive Fumes from 'Smokers' \$10,000

COMMENT: These are more questions of sociology and government rather than research. During World War Two many drivers were limited to about two gallons of gasoline per week. We suffer from congested highways and a polluted atmosphere due to stagnant auto exhaust. We average less than 1.1 passengers per car. Cars are constantly boosting their horsepower. With one passenger per car, this is a waste of fuel and materials. As a stop-gap procedure, controlled or limited driving could reduce the number of cars on the highway about seventy-five percent. This is the world's richest car market with the highest per capita consumption of gasoline. A seventy-five percent reduction in auto travel might further stimulate industrial effort to eliminate pollution. Perhaps it would cut the three-to-five year estimate for improvement of the smog situation.

Ten thousand dollars may not be necessary for specific recommendations to stop the driving of automobiles which give off excessive fumes. The rule for proper maintenance could apply to trucks and buses too.

This entire first program for stop-gap measures recognizes the public need for emergency action. It is particularly appropriate for direct support by the County. The total cost: \$420,000.

II. Development of Exhaust Control Methods

- a. Oxidation of Auto Exhaust \$75,000

COMMENT: This entire second program is directed largely at auto exhaust control methods, but of a longer range and with more thorough development. Under the oxidation program we would study the various catalysts to determine which is most efficient, test various designs and shapes to determine what temperatures are reached under prolonged operation, what metals can be used. All these basic things are still completely unknown.

- b. Evaluation of Proposed Devices \$75,000

COMMENT. A number of devices have been proposed by Houdry, Clayton and others. Even though designed and built without the benefit of fundamental data, it is possible some of these devices could help. A setup is needed to thoroughly test them under all road and traffic conditions.

- c. Methods of Testing and Inspection \$50,000

COMMENT: The converter would be of no use without methods of inspection. This might be a simple instrument available at all filling stations that would test the exhaust gases, just as you test your battery or tires. But this must be developed, or in no time at all nobody would know whether they were working or not.

- d. Coordination with auto industry \$25,000

COMMENT: A much closer coordination is necessary with the auto industry people. This would cover travel, conferences and related costs.

### III. Control of Hydrocarbon Losses During Distribution

- a. Filling Large Tanks \$ 25,000

COMMENT: It may take a lot less than \$25,000 to follow up and complete this control device which the newspapers report some of the local refineries are already doing. We don't know how well these devices to prevent fuel losses during the filling of large tanks will work. Nor do we know how soon they will be installed on all tank-filling operations.

- b. Filling Vehicle Tanks \$ 25,000

COMMENT: We have no evidence that such a device has been developed as yet. Most of the gasoline distributed in the County of Los Angeles is actually handled by some 8,000 independent dealers and not by the refineries at all. Continued control of hydrocarbon losses during marketing and distribution involves working closely with the petroleum industry and others. So we come to the last part of Program 3.

- c. Coordination with Petroleum Industry and Dealers \$ 5,000

### IV. Determination of Smog-forming Potential of Various Pollution Sources

Large test chamber experiments working with actual pollutants, instead of synthetic mixtures; studying Los Angeles smog under controllable conditions.

Total \$250,000

COMMENT: We would prefer to experiment with the entire Los Angeles Basin. This is impossible as we cannot control the weather. In Operation Pilot Plant we could control the temperature, wind, humidity, concentration of pollutants, the amount of light, etc. In a large chamber of special construction, perhaps as big as an airplane hanger, we could supply straight auto exhaust at one time, backyard incinerator smoke at another, hydrocarbons at another, then mixtures of two or more of these pollutants. We could find accurate answers to such questions as: "Does auto exhaust actually form smog?" or "What would be the effect of closing down the refineries, stopping all incinerators or keeping all cars off the roads?" Two years with this operation, whatever the cost, would be time and money saved in trying futile experiments on the whole Basin itself. Operation Pilot Plant is a natural for the University of California, with the main installation probably built at Riverside, with the help of experts from faculties at other campuses and perhaps some of the work carried on at other University of California campuses. Because its operation would increase understanding of air pollution problems in the San Francisco Bay Area, in San Diego and other cities, it is a good State project.

V. Economic and Fact-Finding Study of Public Transportation as One Possible Form of Relief (in cooperation with existing agencies and specialists)

Total \$10,000

COMMENT: We probably need a great deal of information on various public transportation systems, their pros and cons. Here, we recommend only research with existing authorities and transportation experts to assess the advantage each method would offer to reduce air pollution. We have in mind cooperative studies with existing authorities such as the Los Angeles Transit Lines, Metropolitan Coach Lines, the Regional Planning Board and other such groups. It is obvious that trackless trolleys would provide rapid transit with no contribution to air pollution. What are the pros and cons of using them here? What improvement might come from using buses, even of the diesel or LPG types, or some type of petroleum fuel operation? It would mean fewer automobiles, providing the bus system is fast enough and good enough at a price the public can afford. We have the lowest per capita public transportation in the nation, less than the so-called motor capital of Detroit.

VI. Establish and Operate First-Class Public Information Bureau (Using all Media)

Cost not estimated

COMMENT: Those close to the air pollution problem agree that a first-class public information service should be organized and started by the best talent available in the country. It is not surprising if the citizens of Los Angeles County have a confused picture of the smog problem. While there is much we don't know about smog, there are some definite facts which have not been made clear to the public. We should inform them fully as to all that is really known and what we are trying to find out. The only way to do this is to use all media on a continuous basis. Random or spotty articles in the paper, a few minutes here and there on radio or television do not inform the public. Distortions become national and world-wide. Photographs of a luncheon club wearing gas masks distort the situation, are bad publicity. Well-intentioned people, on the other hand, lead the public to expect relief next month or just around the corner. The public information and education service should be rendered by a completely objective impartial body, above political or selfish interest. Perhaps the Foundation or the Los Angeles Chamber of Commerce could do it, separately or in cooperation. Such an operation might be financed by the County.

VII. Research on Combustion Products

|                                     |          |
|-------------------------------------|----------|
| a. Composition of Auto Exhaust      | \$37,850 |
| b. Composition of Incinerator Gases | \$25,000 |
| Total                               | \$62,850 |

COMMENT: Neither of these fumes have been properly and sufficiently tested yet by anyone, although we have some information on auto exhaust composition.



The Foundation placed a project months ago at Midwest Research Institute in Kansas City on auto exhaust composition. This probably will take at least another year to complete. We have just placed a study on incinerator gases with the Battelle Institute in Columbus. We are underwriting these studies ourselves and will report to the public as soon as possible.

VIII. Feasibility and Economic Studies on Disposal of Refuse Without Burning

Total \$ 25,000

COMMENT: We have called a conference of national experts on December 2 and 3 which will do much to bring out the pros and cons of rubbish disposal by various means. As a result, we may recommend disposal of refuse by other means than burning in incinerators. Most ideal solution probably would be to haul the refuse away for use as landfill. It has been said there are enough badlands, ravines and marginal lands within economic radius of the metropolitan district to take care of burial of refuse for many years. Meantime, it could be possible to design, build and put into service some really efficient municipal incinerators, in order to have them available before the rubbish cemeteries are filled.

IX. Measurement of Pollutants, Reaction Products, and Other Factors in Our Environment Which, Separately or in Combination May Be Responsible for Smog

|  |               |
|--|---------------|
| a. Air Tracer Survey                                 | \$ 30,000     |
| b. Visibility  | 2,000         |
| c. Interpretation of 1954 Aerometric Survey          | 25,000        |
| d. Aerometric Survey, Winter-Spring, 1954-55         | 25,000        |
| e. Aerometric Survey, Summer-Fall, 1955              | 566,550       |
| f. Area Distribution of Sources of Air<br>Pollutants | <u>50,000</u> |
| Total  | \$698,550     |

COMMENT: Part of this program is already intensively underway. Further air tracer and visibility studies are needed. When we interpret and evaluate the results of the 1954 survey, we will be in position to conduct a still more effective survey next year, including an area distribution of sources of air pollutants, in which we would determine the quantities and sources more accurately. We must study our environment so we know what we are dealing with. We cannot control something unless we know what it is. Our atmosphere probably contains hundreds of pollutants and we know a little about a few of them.

We are recommending that the Aerometric Survey continue to be supported by the County. The Foundation will undertake the other five items.

## RESEARCH BACKGROUND VI

X. Methods of Measurement

|   |                 |
|---|-----------------|
| a. Mass Spectrometer Studies  | \$ 50,000 *     |
| b. Development of an Automatic No 2 Instrument  | 2,500           |
| c. Development of Infrared Techniques   | 10,000 *        |
| d. Application of Non-Dispersive Infrared Analyzer for Carbon Monoxide                    | 5,000           |
| e. Feasibility Study for Automatic Continuous Measurement of Olefins, Acids and Aldehydes | 2,000           |
| f. Use of Microwave Spectra for Identification of Smog Constituents                       | 33,000 *        |
| g. Continuous Measurements of Atmospheric Ozone by Spectrographic Method                  | 20,000 *        |
| h. Paramagnetic Resonance Studies   | 27,500 *        |
| i. Nuclear Magnetic Resonance   | <u>35,000 *</u> |
| Total   | \$ 195,000      |

\* Could well be supported by the State.

COMMENT: So far, in all air pollution work we have been working with tools comparable to the axe and the sledge hammer of pioneer days. We have selected carefully a list of the greatest needs for scientific tools, both for methods of measurement and instruments. They compare to the development of saws, planes, drills, levels and all the modern tools with which no builder would attempt anything in this modern world. We are trying to build something very important, at the same time seriously handicapped for tools. All scientists in the nation concerned with air pollution recognize this vital need. Much of this work could be done in the laboratories of the University of California and neighboring universities.

XI. Fundamental Research in Physics, Meteorology and Chemistry

|  |                 |
|--|-----------------|
| a. Inversion Modification Studies  | \$ 5,000        |
| b. Development of Machine Methods for Computing Wind Trajectories                | 25,000 F        |
| c. Smog-forming Reactions  | 126,000         |
| d. Review of Literature on Photochemical Reactions in Polluted Atmospheres       | 7,000           |
| e. Photochemical Studies   | 30,000          |
| f. Nature of Reactants with Neutral Buffered Potassium Iodide and Phenolphthalin | 10,000          |
| g. Study of Carbon Isotopes<br>In L. A. Atmosphere                               | 5,000           |
| In General   | 10,000 F        |
| h. Measurement Composition and Mechanism of Formation of Aerosols                | 30,000 F        |
| i. Absorption Spectra of Gaseous Atmospheric Pollutants                          | <u>25,000 F</u> |
| Total  | \$273,000       |
| Total F<br>(Federal support)   | \$ 90,000       |

RESEARCH PROGRAM VII

COMMENT: Just as in measurements and instrumentation, we need more basic scientific knowledge bearing directly on air pollution. If we had the answers which these projects seek now, we would be in a very much better position to diagnose and prescribe. The total of \$273,000 among nine specific projects is the result of competent scientific judgement, on our own team and from the counsel of those we have enlisted in our cause.

# Arthur D. Little, Inc.

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UNIVERSITY  
4-5770

April 20, 1960

Mr. J. Robert Bounds  
Research Laboratories for the Engineering Sciences  
Thornton Hall  
University of Virginia  
Charlottesville, Virginia

Dear Mr. Bounds:

C-59667

Thank you for your letter inquiring about the electrical characteristics of smog. I am sorry to say I am unable to furnish you with the information that you are interested in concerning the electric field etc. during smog conditions.

Some years ago I suggested to the Air Pollution Foundation the desirability of measuring these variables in California. However, I gather from your letter that they have not done this. The experience of ours and others indicates that in smog from industrial pollution the electrical conductivity can be reduced by as much as a factor of 10. I would, therefore, not be surprised to find that the electric field was many times higher than usual during smog conditions. I think it is even possible that the field may get high enough to cause point discharge from vegetation and structures on the surface.

I have had little experience in making measurements during dust storms, but I believe my recollection is correct that Workman and his associates at the New Mexico Institute of Mining & Technology in Socorro have observed rather high reversed fields during dust storms.

Sincerely,

Bernard Vonnegut

BV/bd

October 29, 1954

Dr. Irving Langmuir  
1176 Stratfield Road  
Schenectady, New York

Dear Dr. Langmuir:

59280

I thought that you might be interested in the enclosed letter I am sending to Dr. Hitchcock concerning our conversations yesterday. I can't pretend to have come close to covering everything and you will undoubtedly want to amplify some of my remarks in your letter to Dr. Hitchcock. It is quite possible that I have forgotten to mention important matters or have failed to give an accurate picture of your feelings on various ideas. If I have you can correct any shortcomings in your letter.

It was a pleasure to see you and Mrs. Langmuir again and to have the many different discussions with you. I hope to be able to see you again in Los Angeles.

Very truly yours,

ARTHUR D. LITTLE, INC.

By

Bernard Vonnegut

/jr  
Enclosure

October 28, 1954

Dr. Lauren B. Hitchcock, President  
Southern California Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California

Dear Dr. Hitchcock:

59280

Yesterday I spent a very interesting and stimulating day in Schenectady talking with Dr. Langmuir about various aspects of the smog problem. I find it a formidable, if not impossible job to summarize all of our conversation for you; however, I will try to outline the broad features of our discussion. I believe that Dr. Langmuir plans to write to you very soon outlining his ideas and he will undoubtedly give you a far clearer picture of his thinking than I am able to do.

I showed Langmuir the time lapse movie that Maynard took of the behavior of the black smoke in Texas and he seemed quite impressed. I outlined for him my calculations and estimates concerning the possible behavior of black smoke released in the Los Angeles basin and the various possible benefits that might result. I pointed out that by the use of the black smoke it might be possible to cause pollutants to rise to the inversion base and form a layer there rather than mixing uniformly beneath the inversion as is apparently the case at present. I also explained my idea that it appeared possible that enough heat could be absorbed to carry the smoke and pollutants through the inversion.

I gathered that Langmuir thought the ideas were interesting and that they appeared to have sufficient promise ~~and~~ that they should be pursued further. He seemed to feel much the same as I do. It is very difficult at present to know how valuable the technique would be in smog control but I don't think it should be dismissed without further investigation.

We discussed various effects that the light absorbing smoke might produce aside from the heating that has so far been my primary consideration. One possibility is that the black smoke may be useful in absorbing the shorter wave length radiation that is responsible for the smog producing photochemical reactions. The data I have recently obtained from Godfrey L. Cabot shows that the absorption coefficient of carbon black is greatest in the short wave length region so that carbon smoke should be quite effective in this region.

Dr. Lauren B. Hitchcock  
Southern California Air Pollution Foundation

-2-

October 28, 1954

Langmuir brought out an interesting feature of the behavior of black smoke that had not occurred to me. In his work on screening smokes he found that the visibility looking down through a layer of light smoke was very appreciably increased by the addition of black smoke. The black smoke increases visibility by reducing the amount of light reflected by the white smoke and thereby imposes the optical contrast. Langmuir's observations suggest that even if black smoke did nothing else it might improve visibility in the smog.

We discussed the possibility that carbon smoke particles might be effective catalysts for the decomposition of various chemicals that play a part in the formation of smog. Langmuir felt that the soot might have a catalytic action of this sort but he pointed out that there was a possibility that somehow the carbon black instead of inhibiting the smog producing reactions might increase them. This possibility should certainly be investigated. I am optimistic enough to believe that there is small likelihood that the carbon will accelerate smog formation because if it did such effects should have been observed long ago in our soot filled eastern cities.

Langmuir suggested the idea that it might be possible to reduce smog formation by releasing a white smoke similar to the screening smoke he and Schaefer developed during the last war. By using a somewhat smaller particle size than he used for screening purposes it might be possible to reflect enough of the short wave radiation to reduce the light causing the photochemical reactions.

We were both interested to know whether the smog that forms in sunlight absorbs or reflects an appreciable fraction of the smog producing radiation. We wondered if perhaps because of light absorption the primary smog photochemical reactions might be confined to the top layer of the atmosphere beneath the inversion. The measurements of the intensity of solar radiation that Dr. Renzetti told me you were going to have made should shed light on this matter.

Thus far most of my own thinking has been directed primarily toward the problem of influencing the thermal stability of the atmosphere. My talks with Langmuir, especially about the possible catalytic effects that might be produced by aerosols, clearly indicate the desirability of expanding the scope of my thinking. He felt and I agree that on my next visit, if it can be arranged, I should have some talks with Dr. Hagen-Smit. Langmuir visited him some time ago and was very impressed with his work. If you agree that it is desirable I would like to see Hagen-Smit and discuss the possible role that carbon black and other aerosols might play in catalysing or inhibiting smog formation.

I talked with Langmuir about a recent thought I had, that if hydrogen peroxide plays an important part in smog formation, it might be possible to use a fine aerosol containing the powerful enzyme catalase to decompose it. Langmuir suggested that I talk with Hagen-Smit about this and similar ideas.

I mentioned to Langmuir that I was planning to get our recording condensation nuclei meter into operation and take it to Los Angeles to make measurements. He seemed to think this was a very good idea. I hope that this instrument will be ready to ship in a week or less.

Dr. Lauren B. Hitchcock  
Southern California Air Pollution Foundation

-2-

October 23, 1954

This letter I hope will give you some indication of the gist of my talk with Langmuir. He was interested in all information that I could give him on smog and I left with him my copy of Dr. Neiburger's report on the meteorology of the basin and the 1954 report of SRI on smog. (Incidentally, I would greatly appreciate it if you would please send me another copy of each of these reports as they are very useful references.) I expect that shortly you will be hearing from Langmuir about some of the things I have mentioned as well as other thoughts on smog control.

To return to the black smoke idea, I believe that the only way we will be able to learn what can be accomplished by its use is to make experiments with it in the Los Angeles region where suitable inversions exist. The problems involved in making these experiments are, I presume, political as well as technical.

If Drs. Neiburger and Renzetti feel that such experiments are warranted, do you think that we might get some large refinery to produce the black smoke or do you feel that we should be thinking of methods for producing the smoke ourselves?

Very truly yours,

ARTHUR D. LITTLE, INC.

By

Bernard Vonnegut

P.S. Enclosed is a reprint I obtained from Langmuir of some of his work on generators.

/jr

Enclosure

cc: Dr. Irving Langmuir  
1176 Stratfield Road  
Schenectady, New York



October 25, 1954

Dr. Lauren B. Hitchcock, President  
Southern California Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California

Dear Dr. Hitchcock:

59280

I thought that you might be interested to know that last week, following your suggestion, I made arrangements to visit with Dr. Langmuir in Schenectady. I will see him this Wednesday, October 27. I was pleased to find in my telephone conversation with him that he seems quite interested in the smog problem and that he is already familiar with much of the work that has been done, especially that of Dr. Haagen-Smit. Langmuir seemed interested and amused by the black smoke idea and felt as I do that perhaps soot particles might also be helpful as a catalyst for decomposing ozone or for absorbing some of the gaseous components. I look forward to seeing him and discussing these problems with him. When I return I will let you know of his thoughts.

Through the kindness of the Godfrey L. Cabot Co. research laboratory I have been able to get a copy of one of their reports dealing with the light absorptive properties of aqueous suspensions of some of their carbon blacks. I think it is true, and Dr. Emslie, a physicist in our group does too, that we can get a pretty good estimate of the light absorption in air from these data for aqueous suspensions. If this is true it appears that depending on the particle size it will require carbon concentrations of from .15 to 1.5 tons per square mile to absorb 50 percent of the incident radiation.

Even here in the East there has been quite a lot in the news about your recent smog episode. I am sorry to learn of it and glad that our last report was that a light wind finally carried it away. I gather that this was one of the most severe smog attacks that you have had and I am particularly interested to learn whether or not the smog caused an appreciable diminution in the solar radiation. The remarkable persistence of the smog during this recent long period suggests that the smog may be reflecting enough sunlight to reduce the solar heating that normally lifts the inversion layer.

Very truly yours,

ARTHUR D. LITTLE, INC.

By

Bernard Vonnegut

/jr

R. Stevens  
cc: H.O. McMahon  
K. Maynard

59280

October 14, 1954

1

Summary of Visit to Southern California Air  
Pollution Foundation October 4, 5, 1954.

This visit was made for the purpose of informing the foundation of the progress of our recent thinking on the smog problem.

Several conferences were held with Dr. Hitchcock and the members of his staff and the following matters were discussed:

1. Preliminary calculations were described which indicate that by the use of black light absorbing smoke it may be possible to cause pollutants to warm up sufficiently to break through the inversion. Time lapse motion pictures taken by Maynard were shown illustrating how the black smoke escaping from a carbon black plant in Pampa, Texas causes convective activity which carries it to an altitude of 5000 feet. It was explained that the atmosphere in Texas was far less stable than in Los Angeles so that the behavior of the smoke in Los Angeles might be very different. It was suggested that experiments be undertaken in Los Angeles to see how black smoke would behave there. Dr. Hitchcock felt that before such experiments were undertaken he would like to have Dr. Neiburger of his staff make some further calculations to see if such experiments were warranted. It was agreed that Arthur D. Little should make some preliminary laboratory experiments to determine the absorbtivity of carbon black smoke so that better estimates could be made of the amount of soot that might be required. It was also agreed that Arthur D. Little might further an understanding of the behavior of light absorbing smoke by carrying out some model experiments.
2. It was pointed out to the foundation that during severe smog conditions the smog may cause an appreciable reduction in the amount of sunlight reaching the ground. If a significant amount of solar energy is being reflected by the smog then this might reduce the amountm of solar heating of the air in the basin and thereby aggravate the low inversions which cause the smog problem. Members of the staff of the foundation plan to examine solar radiation data to determine whether or not this is an important factor.
3. The idea continues to crop up that it might be possible to use a large duct or a tunnel through the mountains to remove smog from the Los Angeles basin. At Dr. Hitchcock's request I made a calculation showing that if the wind through a duct were 60 mph it would be necessary to use a duct 1800 ft sq in order to remove a layer of air 600 ft thick from the basin in a period of 24 hours.
4. The suggestion has been advanced that atmospheric electricity might play a role in the smog problem. There appear to be no measurements of space charge and electric fields during smog conditions. It was suggested to the foundation that it is desirable that measurements be made of the effect of the smog on atmospheric electricity. Prof. Holzer of UCLA has the necessary equipment to do this and would probably be glad to carry out such measurements.
5. At the present time the measurements on smog particles appear to have been concerned only with the large aerosol particles above  $.1\mu$  in diameter. It was suggested that measurements should also be made to determine the number of small Aitken nuclei present. These particles may play a role in smog particle formation. Also, since the concentration of these particles is closely related to

Bernard Vonnegut  
/jr

R. Stevens  
cc: H.O. McMahon  
K. Maynard

59280

October 14, 1954

2

Summary of Visit to Southern California Air  
Pollution Foundation October 4, 5, 1954.

severity of pollution, their measurement may provide more detailed information on the trajectories of pollutants. We have a condensation nuclei meter in the laboratory which it may be possible to lend to the foundation for their use. It is planned to put this apparatus into working condition and to try it out in the Los Angeles area.

6. In the course of the discussion it was pointed out to Dr. Hitchcock that the aerosol particles comprising the smog were very similar to those used by Dr. Langmuir and Dr. Schaefer of General Electric in screening smokes. Dr. Hitchcock agreed that Langmuir, because of his background in this field, might be of considerable help as a consultant. He has called Dr. Langmuir by telephone and it is hoped that Langmuir may visit Los Angeles in January. Meanwhile, Dr. Hitchcock has suggested that we visit Langmuir to acquaint him with some of the technical background of the smog problem.

Bernard Vonnegut  
/jr

October 13, 1954

Dr. Lauren B. Hitchcock, President  
Southern California Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California

Dear Dr. Hitchcock:

59280

I am pleased to learn from your recent letter that you had talked with Dr. Langmuir and that he may visit Los Angeles in January. Because of his unusual background in surface chemistry, aerosols, and meteorology, I believe Dr. Langmuir may be able to be of very considerable help in attacking the smog problem. Your suggestion that I visit him in Schenectady to talk with him seems very sound to me and I am getting in touch with him to see if this can be arranged.

I am sorry that I failed to bring the still photographs that Maynard took of the smoke in Texas. You will find them enclosed and I think they may give you a little clearer picture of what was going on.

Since my return I have had the opportunity of studying a report on investigations of carbon black using the electron microscope. This work, done by the Godfrey L. Cabot organization appears to have considerable bearing on the problem of capturing solar radiation. According to this report the tinting strength, or covering power, of carbon black increases with decreasing particle size down to about .015 microns. Below this size no further increase is noted and in fact a slight decrease may take place. The tinting strength must be quite closely related to the absorbtivity and this information is in line with some of the guesses that we were making.

It seems to me that it will be necessary to have some knowledge of the absorption coefficients of black smokes as a function of their mass concentration if we are to make meaningful estimates of the amount of carbon that will be required in order to carry air to or through the inversion. Accordingly, I plan to make some simple experiments to estimate the absorptivity of black smokes.

The very cursory examination that Dr. Renzetti and I made of the Weather Bureau's data on the insolation in Los Angeles left me with the general

Dr. Lauren B. Hitchcock  
Southern California Air Pollution Foundation

-2-

October 13, 1954

impression that the smog probably didn't reduce the sunlight at the surface by more than 10 or 20 percent. We did not have data on the severity of the smog for the month we looked at so this is no more than a rough impression. I feel that the possible reduction of solar radiation by smog is of considerable importance. I think it will be very worthwhile to examine more closely the Weather Bureau data and that from your own instruments to see to what extent the smog is reducing sunlight. This information is of considerable importance as an appreciable reduction of sunlight will not only affect the meteorological situation but will also be a factor governing plant growth.

In addition to the measurements of insolation I still think it is desirable that some measurements be made of the albedo of the smog. These measurements might be made from the blimp with apparatus such as Dr. Neiburger used in his work on stratus.

I will be very much interested to hear of the results of Dr. Neiburger's calculations on the possible behavior of light absorbing smokes and to learn whether or not he feels experiments with them are justified. It is possible that some of his old photographs of black smokes may give valuable clues indicating how they might behave.

I am now in the process of trying to round up the various parts of our condensation nuclei meter and I hope that it will still operate. An instrument such as this should be quite useful in studying smog contamination and I hope to bring it out for a try.

Very truly yours,

ARTHUR D. LITTLE, INC.

By

Bernard Vonnegut

/jr  
Enclosures.

SOUTHERN CALIFORNIA AIR POLLUTION FOUNDATION  
704 SOUTH SPRING ST. ROOM 810  
BURT LEIPER MADISON 6-9441

FOR RELEASE  
SEPT. 29, 1954  
WEDS. AM'S & THEREAFTER

FOUNDATION SETS  
NIGHTTIME TRAP  
FOR CLUE TO SMOG

The Southern California Air Pollution Foundation is trapping night air in the Los Angeles Basin, subjecting it to artificial sunlight, then "dissecting" it chemically in the hope of determining the culprits responsible for smog.

The Foundation today announced a \$126,000 contract with the Stanford Research Institute for this scientific inquiry after sundown. The contract is authorized for one year and will consist of five man-years of scientific effort.

A Foundation spokesman describes the purpose of this project as follows:

"Night air, which does not exhibit smog manifestations, will be subjected to artificial sunlight. In the past, such treatment has made the air smoggy. Different classes of chemicals then will be removed, one at a time, from this smoggy air. Then the air will be re-tested to see if it still produces smog effects. By this type of detective work, it is hoped the chemical culprits responsible for smog will be identified."

Dr. Fred Littman of the Stanford institute, whose pioneering work in air research is widely recognized, will conduct the experiments. SRI has had extensive experience in the studies of the atmosphere and its contaminants.

Dr. Lewis H. Rogers, Senior Chemist of the Foundation, is the project leader.

The objective is to determine the "parent substances" for smog. Under ideal conditions, contaminants would blow out of the basin during the late hours of the day and night. Because of sluggish wind conditions, this ventilation frequently does not occur. When the sun rises, the smog cloud is apt to appear simultaneously far inside the basin and in downtown Los Angeles.

"Going on the assumption that something in the Los Angeles air combines under the action of the sun to cause eye irritation and plant damage," said Dr. Rogers, "we also assume this 'something' is unstable, which, to all intents, disappears at night."

Dr. Littman further explains that the cause or causes of smog could be present much of the time, but due to their instability and minute concentration are difficult to analyse by conventional methods. Plant damage tests will be conducted and humans will be subjected to this nighttime smoggy air for fifteen minutes to a half hour at a time. Past experiments show eye irritation will usually come in the first fifteen minutes.

##

September 27, 1954

Dr. Lauren B. Hitchcock, President  
Southern California Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California

Dear Dr. Hitchcock:

59280

I am sorry that I have not done a better job of keeping you informed on the progress of our work concerning the smog problem. Unexpected duties that have arisen from other commitments have recently prevented me from giving as much time as I would have liked to give to this work. As you know I plan to see you in Los Angeles on Oct. 4 to discuss our findings with you. At present Kiah Maynard and I are working on the analysis of the data he obtained on his trip. On the whole the time lapse pictures he took of the smog from Mt. Wilson show very little activity. However close examination of some of the films has revealed several interesting features. For example, there is some evidence that the solar heating of mountain tops that project up through the smog is sufficient to lift smog above the top of the inversion. On one occasion a short burst of dark smoke released from a stack appears to rise to the top of the smog layer and then a little later to escape into the clear air above. Unfortunately the optical contrast in these pictures is quite poor and these effects are not as clear as one would like.

The pictures of the black smoke that were taken in Texas are far clearer and show that after moving along the ground for several miles the black smoke suddenly rises. From rough estimates it appears that the smoke rises to about 5000 feet above the ground under the influence of the solar heating. The carbon black plant is releasing the smoke at the rate of only about 200 lbs of carbon per hour. I hope that further calculations will confirm my hope that the solar heating technique may be a practical way to remove some contaminants from the Los Angeles basin. I look forward to seeing you next week.

Very truly yours,

ARTHUR D. LITTLE, INC.

By

Bernard Vonnegut

/jr



## MEMORANDUM

To: B. Vonnegut Case: 59280 Date: Sept. 23, 1954 Page: 1

Subject: Preliminary Report on the  
Los Angeles Smog Problem.

A period of 6 days was spent on the summit of Mt. Wilson making lapse time movies of the upper surface of the smog covering the Los Angeles basin. The summit is 5,714 feet above sea level and is located about 15 miles north east of Los Angeles. From this vantage point a view of nearly the entire basin can be had as well as a view of the two natural passes through which the smog can escape from the valley. One to the east and the other to the north. Also, daily, there are three soundings taken from two locations. One is taken at Long Beach and the other at Riverside which is located in the pass to the east of Los Angeles. Also available are the records from the co-operative station which is located on the summit of Mt. Wilson. Most of the lapse time movies made on this first trip were made looking towards the south east where there are isolated mountain peaks which may be used as reference points and also it was hoped that the movement of the smog towards and through the eastern pass would be seen.

During the 6 days there was smog over the basin each day. In the early morning the base of the inversion was, on the average, about 3,000 feet. By early evening this would have risen in altitude to between 5,000 and 6,000 feet. At times waves of smog would pass over Mt. Wilson and it would also be flowing over higher mountains to the east. Every day, during these six days, there would be thin strata cumulus clouds on top of the smog to the south east. These would gradually diminish towards the west until there were none over Los Angeles itself. These clouds were never more than 200 or 300 feet thick and would be very uniform in height. By 10:30 am these clouds would be entirely gone and no more would form during the remainder of the day. There is, to the south east, a mountain whose peak would be visible most of the day. With reference to this there was very little motion in the upper surface of the smog. The upper surface did undulate to a small degree but the periodicity was between 3 and 4 hours and will not be seen in a lapse time movie, such as were taken this time. When the smog passed over Mt. Wilson it did so in waves and with a speed of about 5 miles per hour on these days but due to the uniform surface of the smog both in color and height this wind speed can not be seen looking out over the unbroken smog surface. As the day progressed the smog could be seen flowing slowly up valleys and filling them. At about 3:00 pm there would be a gradual slope, west to east of the upper surface and smog would be spilling over the mountain range into the lower levels to the east. This would mean that the top surface over Los Angeles would be at an altitude of nearly 6,000 feet while further to the east, over the mountain range, it would be at an altitude of over 10,000 feet as it would be flowing over mountains which are above 10,000 feet.

Most of the interesting phenomena, concerning the smog, occurred to the south east. This was because of the mountain peak, reported above, which was more or less isolated in the ocean of smog. One of the first things noticed was the wedges of clear air which would penetrate the upper smog layer to the west and

From Kiah Maynard  
/jr

MEMORANDUM

To: B. Vonnegut                      Case: 59280                      Date: Sept. 23, 1954                      Page: 2

Subject: Preliminary Report on the  
Los Angeles Smog Problem.

2 miles per hour. This would lift off a thin layer of smog and around sunset a number of layers could be seen partially broken away from the original layer. This action would continue until the newest wedge of clear air would be blocked by the mountain range and then all further action would cease. It is not shown whether it was the lateness of the day or the blocking action of the mountains which caused this action to stop.

Another interesting action, which became visible in the lapse time movies, was the action around the above mentioned mountain peak. Evidently there is enough additional heating to the exposed mountain peak so as to create a small amount of thermal activity. Smog can be seen flowing up the sides, both to the west and east of the mountain peak and a new stratus layer forms at a much higher altitude in this same area as well as to the north and east of it. The connecting mass of rising air can not be seen however and it is only assumed that there is a connecting air mass. This action does not occur until around 12 noon or a little later and would still be in progress at sun set.

On the 16th of August a stack was observed in the direction of Pomona which was emitting a dark, almost black, smoke. This was at about 9:30 am, and the valley floor was still visible although there was considerable haze. The tope of the smog was at about 3,000 feet. This smoke rose rapidly to the surface of the smog and then formed a pool there. This pool soon formed a dome on tope of the smog and then rapidly a chimney formed and the entire mass of smoke fed up this chimney and rose into the atmosphere above the smog and then dispersed. This is faintly visible in the lapse time movie taken at this time.

From .....

SOUTHERN CALIFORNIA AIR POLLUTION FOUNDATION  
704 SOUTH SPRING STREET ROOM 810  
BURT LEIPER MADISON 6-9441

RELEASE DATE  
SEPT. 8 AFTERNOON PAPERS  
AND THEREAFTER

The U. S. Navy's lighter-than-air squadrons are patrolling the skies of the Los Angeles Basin for the purpose of determining the concentration, altitude and frequency of the contaminants blamed for smog in this region. The assistance of the Navy was secured upon recommendations of Charles S. Thomas, Secretary of the Navy.

The smog patrol is in addition to the routine training maneuvers of the U. S. Naval Air Reserve Training Unit at Santa Ana. Commander W. R. Peeler, USN, schedules flights in cooperation with the scientists of the Southern California Air Pollution Foundation. On specified days, when the winds are most sluggish, when the inversion layer is low, when conditions are most "favorable" for smog -- that is when the smog-sampling flight is added to the regulation patrol of Commander Peeler's airship squadrons. These blimp flights will continue through the month of November, in coordination with the overall ground and upper winds project now underway by the Foundation. This is another important leg of the Aerometric Survey.

Questions which the Foundation is asking on its Navy patrols through the Basin are these:

Do these contaminants, such as ozone and nitrogen dioxide, have a maximum concentration from the ground up to the base of the inversion, then decrease rapidly from the base of the inversion upward?

Or, to put it another way: Do the oxidants, or pollution formed by the action of the sun on the waste products of gasoline, auto exhausts and industry, show a marked decline above that temperature ceiling which locks contamination in the Basin?

SOUTHERN CALIFORNIA AIR POLLUTION FOUNDATION  
704 SOUTH SPRING ST.  
BUPT LEIPER

ROOM 810  
MADISON 6-9441

II  
RELEASE DATE  
SEPTEMBER 8 AFTERNOON  
PAPERS OR THEREAFTER

Is nitrogen dioxide in the air we breathe strictly a product of combustion engines; is there some other chemical or meteorological answer?

The log of a typical flight is as follows:

At 10 a.m. in the ready room at the Santa Ana base, Commander Peeler receives a report on the height of the inversion base, on visibility and wind conditions. A naval reserve unit is prepared to make the flight. In this case, Lieutenant Commanders James V. Priest of San Marino and Royal A. Lett, Jr., of Garden Grove are the pilots. Members of the crew are Donald L. Cameron of Westminster; Joseph W. Perry, Norwalk, Bob L. Cavness, Whiting, Indiana, and Lyle C. Miller, Corona Del Mar.

Foundation consultant on this flight is Dr. Morris Neiburger, senior meteorologist. Taking samples for this particular cruise is Maurice Ballas of the Truesdail Laboratories of Los Angeles. Dr. L. H. Rogers, Foundation's senior chemist, alternates with Dr. Neiburger.

"Our sampling flight pattern," says Dr. Neiburger, "is from Santa Ana out over the Los Angeles Harbor, then north to Dominguez, where we have a ground station. With the permission of the Civil Aeronautics Authority, we fly just below the airways.

"At 500 feet, over Dominguez, we take our first samples of oxidants and nitrogen oxides. The blimp is particularly apt for this purpose because of its ability to fly slowly and at low levels. Samples are taken over a relatively small area in the vicinity of the ground stations. Samples have been taken by air before, but not over a systematic period and location and with the frequency we contemplate.

"Each sample requires about seven minutes. A signal to the pilots and we rise to about 1,000 feet for our second sampling below the inversion layer.

SOUTHERN CALIFORNIA AIR POLLUTION FOUNDATION  
704 SOUTH SPRING STREET ROOM 810  
BURT LEIPER MADISON 6-9441

III  
RELEASE DATE  
SEPTEMBER 8 AFTERNOON  
PAPERS OR THEREAFTER

Then to 3,000 feet, where, on this particular flight we broke through the smog and haze where visibility was perfect.

"A sampling at 3,000 feet and then we set our aerial compass directly north on Figueroa Street for the downtown area. Our arrival over our downtown station, near City Hall and the Freeway "cloverleaf" is shortly before noon.

"Here, samples are taken in reverse order: at 3,000 feet, at 1,000 feet and at 500 feet.

"Then the blimp begins a series of up-and-down trips so we can determine the slope of the inversion layer from downtown to the ocean. Using Venice Boulevard as our marker, the blimp heads for the city of Venice. During each dip and each rise, we record time, temperature and humidity, which helps to fix the height of the base of the inversion layer."

From Venice, the Naval squadron carries out its routine training maneuvers. This particular day's smog mission has been completed. In two months or so, interpretation of data should be possible, Dr. Neiburger said. Findings will be related to the chemical and other observations and tests along the surface of the basin -- a part of the Summer and Fall program of the Southern California Air Pollution Foundation -- this part made possible by the U.S. Navy's lighter-than-air ships.

*B. Vonnegut* *Wallace Murray*

# NEWS

From

# AIR POLLUTION CONTROL ASSOCIATION

4400 Fifth Ave., Pittsburgh 13, Pa.

Harry C. Ballman, Executive Secretary

September 7, 1954

For the first time anywhere, practical aspects of efficiency and cost, along with specific details on installations of many types of air pollution control devices, will be presented at the Semi-Annual Technical Conference of the national Air Pollution Control Association scheduled for November 4, 5 and 6 in Los Angeles.

Industry-wide reports on control of air contaminants, using existing installations as illustrations, have been programmed as follows:

THURSDAY MORNING, November 4

Los Angeles: An Air Pollution Test Tube

Operation and cost of control equipment in the steel industry

Economics of air pollution control in the gray iron industry

Solutions to air pollution control in refining non-ferrous metals

THURSDAY LUNCHEON

Guest speaker will be Charles A. Chayne, vice-president in charge of engineering, General Motors Corporation

THURSDAY AFTERNOON

Control of emissions from processing non-combustible municipal refuse

Engineering combustible waste disposal to prevent air pollution

Automobile exhaust problem

MORE

FRIDAY MORNING, November 5

Control of emissions from asphalt roofing plants  
Latest control measures in the petroleum industry  
Sampling for airborne radioactivity

FRIDAY AFTERNOON

Conducted tour of plants to view control installations

SATURDAY MORNING, November 6

Individual tours as requested. Los Angeles County Air Pollution  
Control District headquarters open for inspection

Persons attending the three-day-long event will find a pool of  
technical knowledge that will provide basic facts, not merely theory,  
on reduction of atmospheric contamination, Gordon P. Larson, president  
of the Association and director of the Los Angeles County Air Pollution  
Control District stated.

Convention chairman is William L. Stewart, Jr., executive vice-  
president of the Union Oil Company of California, while honorary  
chairman is John Anson Ford, chairman of the Los Angeles County  
Board of Supervisors. Dr. Arnold O. Beckman, president of Beckman  
Instruments, Inc., is technical program chairman.

Advance registration should be made through Edward S. Feldman,  
2155 East Seventh Street, Los Angeles 23, California.

AIR MAIL

August 10, 1954

Dr. Lauren B. Hitchcock  
Southern California Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California

Dear Dr. Hitchcock:

59186

According to present plans Mr. Kiah Maynard of our group will arrive in Los Angeles by TWA early in the morning on Friday, August 13. I had hoped that he would be able to get there sooner, but the airline strike apparently makes it quite difficult to get reservations at present.

I hope that Maynard's trip will serve several purposes. In the first place I would like to have him meet some of the members of your staff and to observe the smog problem first hand. Maynard was quite active in a number of different capacities in the work of Project Cirrus at General Electric and has shown considerable talent in meteorological observations. Although he has had little formal meteorological education I believe he has a much sounder grasp of synoptic meteorology than I do and I believe his observations in Los Angeles will prove of great help to us here in approaching the problem of smog dissipation. If it can be arranged I would like to have Maynard find out exactly what time lapse smog pictures are available. If suitable conditions exist during his visit I would like to have him take some pictures of his own with particular emphasis on how smog escapes naturally from the Los Angeles basin.

I realize that the week of August 16 will be a very busy one for you and your staff. I believe that a brief visit at your office on Friday will be all of your time that he will require and that much of the information that he is interested in will be available from the U.S. Weather Bureau.

It is planned that Maynard will go from Los Angeles to Texas to obtain information on the meteorological effects that we have heard are produced by black smoke released by carbon black plants. I am now in the process of obtaining information from the Godfrey L. Cabot Company who operate these plants concerning the rate at which these plants release carbon black and the particle size of the smokes.



Dr. Lauren B. Hitchcock

-2-

August 10, 1954

It is my hope that Maynard will be able to secure time lapse motion pictures from which we can learn something of how black smokes might alter the behavior of the atmosphere.

I contemplate that Maynard's trip will furnish us with information that will serve as the basis for calculations and model experiments that will help us to evaluate the possibility of aiding Nature in carrying away smog.

I plan to come to Los Angeles sometime in September at your convenience to tell you what we have been doing and to discuss whatever conclusions we may have reached. I look forward to seeing you and talking with your staff again.

Very truly yours,

ARTHUR D. LITTLE, INC.

By

*BV JR*

Bernard Vonnegut

/jr

SOUTHERN CALIFORNIA AIR POLLUTION FOUNDATION  
70<sup>1</sup>/<sub>4</sub> SOUTH SPRING ST. ROOM 810  
BURT LEIPER MADISON 6-9441

IMMEDIATE RELEASE

FOUNDATION ASKS QUESTION:

"WHAT IS AUTO EXHAUST"

The Southern California Air Pollution Foundation is asking the question: "What, exactly, is the makeup, or composition, of auto exhaust?"

The Foundation, granting that an exact chemical answer may never be found to this question, is placing the order for an alternative if such is found to be necessary. The order: to narrow the field of identification of components of that auto exhaust; to assess the evidence which, to a major degree, points the finger of responsibility for smog on the auto exhaust.

The Foundation anticipates many steps in seeking the answers; it is weighing the evidence on hand. It is making an independent check by contracting for the services of the Midwest Research Institute in Kansas City, Missouri. Chemists, mechanical engineers and plant pathologists, altogether a group of scientists at MRI whose combination of personnel has been selected by the Foundation as competent for the attempted task, will make this check on auto exhaust composition.

Dr. W. L. Faith, Deputy Director and Chief Engineer for the Foundation, announces the signing of a \$37,850 contract with the Kansas City institute. This particular research, the first announced out-of-state project for the Foundation, initiates a much larger program concerned with the contribution of combustion to impurities in the Los Angeles air.

Dr. Faith said:

"We have very little information, actually, on composition of the auto exhausts. To a major degree we do have circumstantial evidence which points the finger directly at the exhaust as being responsible for smog, but we haven't the proof.

"Someone must develop better methods for analyzing exhaust gases under various conditions. We may never find out, chemically speaking, exactly which molecules of the auto exhaust lead to smog. If we find out, however, that certain parts of the exhaust gases are responsible, then we can go ahead with a program aimed at solution of the problem."

"Assuming that some material in the exhaust does cause our eyes to smart, that it does damage our plants and cut down our visibility, then we still must find the means to a device which reduces or remedies this problem."

"That is why the need still exists," Dr. Faith said, "for an independent check on the makeup of auto exhaust gases." He added that this is one purpose for the Foundation's August Conference on Vehicle Combustion Products and Other Emissions: to determine what industrial engineers know about the composition of these gases."

The August Conference will be clinical and technical, a concentration of scientific and industrial knowledge, men free to speak their minds at closed panel sessions at The Huntington-Sheraton in Pasadena on August 19, 20 and 21. Experts from all parts of the nation will study composition, analysis, the effects of fuels and additives, the engineering designs and devices, the chemical reactions in polluted atmospheres.

While this closed, clinical session is in progress, other experts will be working in Kansas City on the same problem. They will make use of test plants, plants which are excellent indicators of smog. They will use the pinto bean. They will subject this plant to combinations of auto exhaust and ozone, that high oxident content which is suspect in the atmosphere of the Los Angeles Basin.

They will probably take their samples from automobile engines operating under actual road conditions. One engine will be in excellent mechanical condition; another will have been driven upwards of 100,000 miles. Samples will be collected from engines at normal cruising speed, decelerating, idling. Gasolines will be used which contain additives; others will be free of additives.

Some of the methods will not be new. For instance, exhaust gases will be separated into classes, physically and chemically, for a lead as to the type of material causing plant damage. The theory: perhaps all classes of gas within that exhaust cause plant damage; perhaps only one. This is similar to work done previously by Dr. A. G. Haagen-Smit of the California Institute of Technology. There is a difference, however. Haagen-Smit's work was done with gasoline. The Midwest Research Institute will use fractions of auto exhaust instead of fractions of gasoline.

'WORLD'S BIGGEST AIR  
LABORATORY' TEST BEGINS

Smog is a criminal with many disguises. There are many suspects and many clues to its identity.

Today, the Southern California Air Pollution Foundation joined hands with the Los Angeles Air Pollution Control District to help narrow the list of suspects and corner the elusive clues. Together, they launched "Operation Aeromet" in the biggest air laboratory in the world, the Los Angeles Basin.

Simultaneously and continuously, on a twenty-four hour basis, for the next 120 days, Man and his scientific machines will work on what is technically known as an Aerometric Survey. A calculated scientific Summer and Fall program will test new techniques, confirm or discard old ones, gather hundreds of data on suspects such as oxidants in the air, metallic dusts, nitrogen oxides, hydrocarbons and others.

Today, the press, radio and television newsmen examined what will be the largest research project of its kind ever attempted. They saw a single portion of that project at the Control District Office in Vernon. Other stations will be located at Venice, in the Wilshire District, in downtown Los Angeles, Pasadena and Burbank; additional ones at Dominguez, Artesia, Rivera, Bassett and Azusa; stations outside the Basin will be located at Santa Barbara and Riverside.

Operation Aeromet is largely a teamwork proposition, proposed by Dr. L. B. Hitchcock, President and Managi Director of the Foundation; approved for County participation by Gordon P. Larson, Director of the District. Funds for the survey were approved by the County Supervisors. This will amount to \$128,550 for the current year.

Dr. Hitchcock told newsmen the Foundation's program will cost \$100,000 a month in addition to operation costs, for the next five months of this year. This cost figure includes other projects to be conducted in what Dr. Hitchcock calls the

"biggest air laboratory in the world." He said the Aerometric Survey alone will require from 550 to 700 measurements per day for the next 120 days. This huge pile of findings will be correlated and interpreted by scientific methods with the help of mechanical analyzers. Results of the survey should be available early in 1955.

The juggernaut of the operation is the oxidant recorder. Huge blue-gray boxes, pumping in air from the Basin, hour by hour, day by day, will operate along known wind currents. Ozone (an oxidant) is a known suspect in the smog picture. Oxidants in the air usually hit a high peak in the Basin around noon. Often, their presence coincides with watery eyes, bad visibility and bad-tempered Angelenos.

This recorder and other measurements and detectors may establish a relationship between the time-of-day, temperature, wind direction, humidity, the presence of other contaminants in the air--hopefully a lead to the 'how' and the 'why' of smog.

On certain specific days, to be judged by the meteorologists, an air tracer device will spout into action. Extremely small particles will be ejected from a machine somewhere in the Area of Palos Verdes. The dispersal points will change. Miles away, sampling machines will pick up these tracers by use of filters.

The samplers operate much as vacuum cleaners, picking up these minute quantities of pseudo-pollutants. The air tracer study may confirm a theory: that the paths of the wind along the surface of the Basin are true indicators of the movements of pollutants. This may not be so. The technique would be a valuable one if proved to be sound. The Foundation and the District are placing a great measure of hope in Operation Aeromet to give the answer.

Operation Aeromet has many parts and parcels. On display was a sampler for nitrogen dioxide, a suspect in combustion processes. A plant damage project is being conducted at six stations by UC at Riverside, as well as the extensive work now in progress there. It is already known that smog damages plants. These plants will be exposed during the tests as a measurement of damage. Other operations include a hydrocarbon project, tests of visibility, measurements of sulphur dioxide and carbon dioxide. All this is now underway, in addition to a systematic recording of eye-irritation in the vicinity of the oxidant stations.

MEMORANDUM

To: Raymond Stevens

Case: 1-5115

Date: July 16, 1954

Page: 1

Subject: Southern California Air Pollution Foundation

There appear to be two general methods for alleviating the smog problem in the Los Angeles basin. These are: (1) Prevent the introduction into the atmosphere of those gases or aerosols that cause the smog; and (2) Dissipate the smog or smog producing substances after their release into the atmosphere. Neither of these two methods appears to be simple or attractive. If the smog producing materials are to be prevented from escaping into the atmosphere, it must first be established what these substances are. When this has been done, it will be necessary to devise and install equipment to prevent their production or their dispersal into the atmosphere. If such measures can be devised, it seems certain that they will be costly to establish and maintain. If, as it seems probable, individual automobiles and incinerators are an important source of smog, then the further problem will arise of policing the large numbers of potential individual sources.

The second general method of attacking the smog problem is to remove the smog. Usually the smog is not severe because winds carry it away. However, when the base of the inversion is low and when there is little wind the accumulation of fog becomes serious. Brute force methods such as removing mountains or installing an enormous ventilating system are clearly prohibitively expensive. However, it may be possible to devise more subtle and practical schemes. The problem of controlling smog is certainly sufficiently difficult and important that the possibility of smog dissipation should be given serious consideration.

It is proposed that Arthur D. Little, Inc., concern itself with a study of the possible solution of the problem.

It is visualized that a study of this sort might be divided into two parts. The first of these would be a study of how the smog is carried away under normal conditions. Some estimates should be obtained of the natural flux of smog or smog producing materials out of the Los Angeles Basin. It appears that although a considerable amount of work has been done in measuring wind trajectories of air masses within the basin there is little information on the movement of air out of the basin. There must always be a steady flux of air and smog out of the basin whose magnitude depends on such variables as the speed and direction of the wind at various altitudes and the thickness and strength of the inversion. If rough estimates can be obtained of how the smog is removed naturally and how this rate of removal is affected by various weather conditions, this information will serve as a sound basis for evaluating the possibility of smog dissipation.

The second part of a study of fog removal will involve consideration of possible methods for promoting the natural movement of smog out of the basin. One such method is to promote convective activity and mixing by utilizing solar energy.

This might be done by releasing heat absorbing smokes in such a way as to increase the rate at which smog is removed from the basin. Rough calculations indicate

From  
Bernard Vonnegut/cd

MEMORANDUM

To Raymond Stevens

Case: 1-5115

Date: July 16, 1954

Page: 2

Subject: Southern California Air Pollution Foundation

that carbon black suitably dispersed will absorb in about two seconds as much solar energy as it would produce if it were burned. This indicates that by the use of this technique it may be possible to increase significantly the heating of selected air masses.

In order to explore this aspect of smog removal it is proposed that preliminary theoretical calculations and laboratory work be carried out to determine the best methods of producing radiation absorbing smokes. It is also proposed that a preliminary study be made of the behavior of the carbon black smokes released into the atmosphere by carbon black manufacturing plants. It has been reported that solar heating of these smokes frequently causes penetration of inversions and the formation of cumulus clouds. Time lapse photography of this phenomenon in conjunction with information on meteorological variables at the time would provide preliminary data on the basis of which this technique of smog removal could be evaluated.

It is proposed that personnel of the Arthur D. Little Co., will make periodic visits to Los Angeles to confer with the staff of the Southern California Air Pollution Foundation on the possibilities of smog dissipation. During these visits it is hoped to make observations that will give indications as to the best methods for attacking this problem.

Although it is expected that the activities of Arthur D. Little, Inc., will initially be concerned primarily with the possibility of smog dissipation, it is anticipated that as this company becomes increasingly familiar with the smog problem it will be able to make significant contributions along other lines as well.

From.....Vonnegut/cd.....



# TELEGRAM

ARTHUR D. LITTLE, Inc.  
RESEARCH-ENGINEERING-INVESTIGATIONS  
CAMBRIDGE 42, MASS.

NL

DR. LAUREN B. HITCHCOCK, PRESIDENT  
SOUTHERN CALIFORNIA AIR POLLUTION FOUNDATION  
704 SOUTH SPRING STREET  
LOS ANGELES 14, CALIFORNIA

MR. KIAH MAYNARD OF OUR GROUP WILL ARRIVE LOS ANGELES  
FRIDAY 13 6:00 AM TWA AND WILL COME TO YOUR OFFICE AT  
9:00 AM

BERNARD VONNEGUT

1-1529

5966 Pimenta Avenue  
Lakewood 11, California

August 18, 1954

Dr. Lauren B. Hitchcock  
President and Managing Director  
Southern California Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California



Dear Dr. Hitchcock,

I greatly enjoyed your talk last night at AICHE. In my position at Union Oil as a member of Manufacturing Economics, a staff group reporting to the vice president in charge of manufacturing, I have done some work on release of contaminants to the atmosphere. Your talk, to me at least, hit the nail on the head.

As a reader of science fiction I was very interested in your "Buck Roger" idea to open a hole through the inversion layer. Another possibility that occurred to me was the use of a group of large solar mirrors to create a hot column of air that could possibly break through the

inversion layer. If care were taken to make the mirrors have a poor focal point it is possible that ozone production could be kept quite low. This idea may be as full of hot air as the column the solar mirrors would conceivably produce, but you asked for any ideas we might have.

Again may I say that I greatly enjoyed your talk. One thing that really impressed me was your "Smog Basin" model. I had never thought of it as being so wafer thin.

Yours very truly,

Austin R. McCreery

Aug 18, 1951

Hi Bernie,

Good morning

well it looks as though my luck has run out up here. I will go down tomorrow morning and leave for Texas on the first plane I can. The smog is going over the top of the mt. and there is not enough contrast to make it worth while to try to photograph any thing. They say this is very rare. Because of the increased depth of the smog it has made visibility better in the L.A. Basin and they are saying in their weather broadcasts that the valley is full of smog. well it is still there.

I hope I have some lapse time movies of how it tries to break up. The smog will grow deeper as the day grows older until the whole valley is filled. There seems to be a slight wind from the East and this prevents the smog from spilling over the mts to the east by holding the inversion just below the mt. tops. When there are lower passes the smog will pass off to the east and you can see the smog in small amounts east of the range.

At night the air rapidly cools and the inversion goes down to lower levels. Due to the lack of sunlight on top of the smog it looks very clear in the valley from down there but it is still there and can be seen from up here. I have tried to photograph that also by time exposures. In the morning this residue is very prominent and has a very thin stratus deck on it a little east of L.A. but within the basin. This white deck prevents the sun from doing much heating and soon the density of the smog is increased by a new supply of contamination

which prevents any heating of the valley floor during the rest of the day.

well I will write this all up in a sort of memo and I think it has been very worth while.

I have talked with Mr. J. Hichet who is the permanent resident at the Col Tech observatory and he tells me that there is no atmospheric electricity measurements going on here but he thinks they are being made on the higher mts. I will try to find out more about them.

well I want to get this out in the mail which leaves in a few minutes. I hope to see you back there soon. I will give you a call as soon as I do get back in the east.

as always  
Ki

## Fatal Smogs Said To Hold Salt Particles

NEW YORK, Sept. 14 (AP)—Tiny particles of certain salts may be the invisible killers in fatal smogs, a Mellon Institute scientist told the American Chemical Society today.

W. C. L. Hemeon, engineering director of the institute's Industrial Hygiene Foundation of America, Pittsburgh, told of a new analysis of air samples saved from the Donora, Pa., smog in 1948 and the great London smog in 1952, blamed for contributing to the deaths of 4,000 persons.

Hemeon said the dangerous thing seems to be acidic salts, usually sulfates and chlorides of ammonia combined with zinc or other metals. The sulfur part comes from coal smoke, he said.

The salt particles dissolve in liquids in the lungs and throats, causing acute irritation, he said.

Hemeon expressed his belief that deaths and illnesses from severe smogs probably come from simple irritation of the breathing apparatus by such substances, and are not due to poisoning by sulfur dioxide or other gases in the air.

The air samples were analyzed to pull out tiny particles which would dissolve in water.

About 20 per cent of the particles from the Donora air would dissolve in water. And 58 per cent of this soluble material apparently contained metallic ammonium sulfates, Hemeon said. A similar check on typical air samples from two towns near Pittsburgh showed only nine to 13 per cent of this salt.

Hemeon said the water-soluble particles from the London smog were made up mainly of ammonium chloride and calcium sulfate combined with traces of sodium, potassium, aluminum, magnesium, zinc and other metals.

## INCINERATORS *Smog*

Continued from First Page  
be able to determine whether the change will make any appreciable difference in smog density.

Burbank yesterday joined Los Angeles and the other cities in switching burning hours to late afternoon. The county territories will make the change Dec. 3.

Meanwhile, W. Blake Fairweather, foreman pro tem of the grand jury, in a statement, responded to a stern warning given Tuesday by Superior Judge Harold Schweitzer, in charge of the grand jury.

The grand jury gave up its extensive inquiry into smog control law enforcement following Judge Schweitzer's admonishing letter to the jury.

Judge Schweitzer hit at oral statements made by jury members to the press, at the possibility of prosecuting grand jurymen who violate their oath of secrecy by divulging how their colleagues voted on the smog question and at jury tampering by outside persons.

### 'Honest Errors'

Fairweather stated that, in view of the confusion prevailing among "a great number of organizations and committees working" on the smog problem, including "scientists, engineers and public officials . . . it must not be too disappointing to the citizens of Los Angeles County that the county grand jury likewise conclude their deliberations with nothing more than added confusion and disappointment."

He said that if errors were made by grand jury members

they were "honest errors and there certainly was no intent to break laws"

"The public must keep in mind that the 19 members of the grand jury are lay citizens of the community and as vitally interested in the elimination of air pollution as all citizens are . . .

"Speaking not as the jury foreman, but as an individual juror," he concluded, "I sincerely hope that all citizens will join hands with the constituted authorities in constructive efforts to rid our community of this condition that has too long troubled us."

Southern California Air Pollution Foundation  
704 South Spring Street  
Los Angeles 14, California

December 31, 1954

Attention: Dr. Lauren B. Hitchcock, President

*A. G. Imelci*

This bill was mailed 1/14  
Unless we hear from you to the  
contrary, the same wording will  
be used for next month's invoice.

*JRD*

12-249

Case 59280

Professional services relative to our  
participation in your smog control program.

\$510.00

Disbursed Expenses

60.11

\$570.11

Authorization: Dr. L. B. Hitchcock's signature  
on July 23, 1954 to our proposal  
dated July 16, 1954.

JAN 14 1955

SAN FRAN. EXAMINER 12/31/54

# Science Maps War On Smog Menace

## UC Session Topic

By SHERMAN MILLER

Smog got official scientific standing yesterday as a grave menace to American city life.

The discussion at the meeting of the American Association for the Advancement of Science in Berkeley sounded like war talk.

Smog was underlined as the enemy, with research and huge sums of money necessary as the weapons.

### SCIENTIFIC VIEWPOINT.

Giving first recognition to the problem on an AAAS program, the scientists expressed these viewpoints:

1—The very existence of San Francisco and other cities may depend on ridding the air of the harmful chemicals that cause damage ranging from human distress to the withering of agricultural crops.

2—The cost of providing a city with relatively pure air may be comparable to the expenditures for other such indispensable services as water, sewers and highways.

3—Damage to agricultural plants from smog was first observed in the San Francisco Bay area in 1950, and the variety of crops affected, the area involved, and the dollar loss, have been increasing since then.

4—The combustion processes, in transportation, heating and generation of power, are responsible for a large part of the air pollution, and improvement of combustion processes must be a major goal in combatting smog.

5—Poor combustion of gas in cars, with the unburned fuel contributing to the smog problem, costs the country possibly a \$1,000,000,000 a year.

6—The indirect costs of smog, form illness, corrosion, deterioration of paint, cracking of rubber, soiling and deterioration of clothing, and other effects, runs into the hundreds of millions of dollars.

### TELLS OF THREAT.

Lauren B. Hitchcock, president of the Southern California Air Pollution Foundation, who led the discussion on smog, said of the threat to cities:

"If the urban civilization to which science has contributed

RS BV

## Smog Study Taken Up By Science Congress

(Continued from Page 1)

so richly is to keep on growing or even to continue, we who are technologically motivated by the same dedication to the service of man and his welfare, must promptly undertake comprehensive programs directed at the full elucidation of our air pollution problems in the hope of finding suitable remedies before more lasting damage ensues.

"Surely the same genius who brought forth these sources of pollution can contrive the cures."

Hitchcock said of the cost of overcoming pollution:

"The cost of providing a metropolitan area with tolerable air is likely to be considerable. The sooner this probability is appreciated by society, the sooner will adequate financial support be available for the necessary scientific and engineering work.

### COST CITED.

"A fallacy which has seriously interfered with progress until now has been that air pollution could be cured for little or nothing by turning some valves or plugging some pipes."

Using Los Angeles as an example, Hitchcock said the water system there cost \$750,000,000, the sewer system \$250,000,000 and the highway system several billion dollars.

"While it is impossible to predict what tolerable air may cost, it may well be comparable to some of these other indispensable services which

we already enjoy in all our cities," he added.

Dr. John T. Middleton, plant pathologist of the University of California at Riverside, spoke on the "response of plants to air pollution."

### CROP DAMAGE.

He said that smog damages a wide range of field, fruit, vine, ornamental and vegetable crops in the San Francisco and Los Angeles areas.

"Air pollution is now a limiting factor in the production of certain agricultural crops and is responsible for the changing cropping systems, increased cost of production, and need for resistant crops and methods for protecting plants from injury," Middleton declared.

### PLACES BLAME.

Hitchcock placed the blame for much of the smog on the combustion processes, saying:

"Our present combustion processes are all imperfect, some of them atrociously so.

"They contribute unburned fuel, partially oxidized fuel, thermally cracked products, acids, aldehydes and other organic compounds, oxides of sulphur and nitrogen, and particulate matter such as ash and soot.

"Improvement of combustion processes we see as the first major goal for science and technology."

Hitchcock also gave the estimates of the high direct and indirect cost of smog.



*Dr. Vonnegut*

MAY 5 - RECD

Recently we asked a number of industrial leaders what they thought of air pollution problems. A summary of these answers is enclosed.

We would, of course, welcome any comments. If you would like additional copies of this report, please let us know.

John Hoving

**Pendray & Company**

PUBLIC RELATIONS

55 WEST 42 STREET, NEW YORK 36, N.Y.

LONGACRE 4-0595

INTER-OFFICE MEMORANDUM

To: B. Vonnegut  
cc: E. P. Stevenson

Bldg: 15  
Room: 304W  
Date: March 2, 1959

From: C. J. Matthew Ext: \_\_\_\_\_ (If Reply Necessary)

Attached is a copy of another clipping on the smog problem in Los Angeles which I thought might be of interest to you.

*Chris*

# SKY-SEEDING PLAN PUSHED TO CLEAR SMOG FROM BASIN

## County Told Way to Dispel Air Inversion

BY LES WAGNER  
Staff Writer

A plan to curtail smog by peppering the skies with chemicals was outlined to the Board of Supervisors today by a former Caltech professor.

Boyd Quate told the board work in suppressing hail by chemical means has convinced him the same technique would work to dispel air inversion.

It's such inversion—hot air overlying cool air—that keeps smog trapped in the Los Angeles basin.

### Method Told

Quate, operator of Weather Engineers, a firm near Sacramento, said in hail suppression work upper layers of air are cooled and the lower layers are warmed.

"When we release certain types of chemicals, we get observable effects — we've seen these things happen," he said. "I think we could similarly modify a smog inversion by chemical means."

Quate did not specify the chemicals used.

The board granted Quate's request for a meeting with the county's chief administrator and counsel and the Air Pollution Control District to thrash out plans to test the chemical scheme to

### 40 Days Needed

The meeting was set for late this afternoon in the office of Supervisor Warren Dorn.

Quate said a test of his plan would require about 40 days of good flying weather. He put the price at about \$220,000 — and indicated he would pay half of it.

Quate was accompanied to the morning meeting by former Assemblyman Francis C. Lindsay, who is associated in the chemical-control plan with him. Said Lindsay:

"We're not promising any spectacular results, but we do think that at the end of the trial period, maybe the supervisors would want to extend it."

### Haste Advocated

Lindsay said he and Quate would like to get the experiment under way by March 1 to cover smogless as well as smoggy periods.

The former Assemblyman is no stranger to smog. He headed a smog committee in Sacramento in 1955 and heard of the many devices — some impossible, some practical — by which inventors sought to eliminate it.

Lindsay said Quate formerly was associated with

Turn to Page 3, Column 3

## Chemical Seeding Urged to Clear Skies of Smog

Continued from First Page  
Dr. Irving Krick, who also is interested in weather modification.

### Forecasting Plan

Krick came here last March to confer with smog control director Smith Griswold on the possibility of making a long-range study of weather records.

With these records, he said he could quickly deliver a weather forecast, week by week, for the next five years which would alert the APCD to smog periods.

And with the data, he said he could determine what should be done to change the chemical patterns of smog.

He envisioned seeding the atmosphere of the metropolitan basin with a reactant or catalyst which could change the sulfur dioxide or oxides of nitrogen to something less irritating.

Krick thought the five-year survey might cost \$10 million, but he didn't know who could or should foot the bill—the APCD or industry.



**CONFER ON SMOG RESEARCH**—Dr. A. M. Zarem, right, manager of Stanford Research Institute, confers with Dr. Irving Langmuir, Nobel Prize chemist, on possible experiments on smog problem. Dr. Langmuir proposed smoke screen above city.

Times photo

# Smokescreen Over City Proposed to Lift Smog

## Nobel Prize-Winning Chemist Suggests Experiment to Eliminate Sun's Influence

A world-famous chemist yesterday proposed the laying of a gigantic smoke screen above Los Angeles on smoggy days to eliminate the smog-producing influence of the sun.

Dr. Irving Langmuir, a Nobel Prize-winning chemist, made the suggestion at the National Air Pollution Symposium in the Huntington Sheraton Hotel, Pasadena.

"It would be strictly an experiment, of course," he said, "but you might find you like the effect and want to do it whenever the smog is severe."

### Highlights Final Session

Dr. Langmuir's proposal highlighted the final session of the three-day symposium sponsored by the Stanford Research Institute. Other developments of the day included a suggestion for a Presidential advisory committee on

smog and a disclosure that smog is now causing damage to plants from Santa Barbara to the Mexican border.

Dr. Langmuir has been connected with the General Electric research laboratory at Schenectady, N.Y., since 1909, and is considered the father of cloud seeding. He developed, in conjunction with Dr. Vincent J. Schaefer, the smoke-laying chemicals used by the Army and Navy during World War II.

They finally succeeded in producing a dense white smoke that was absolutely harmless and nonirritating to humans and it is this substance that Dr. Langmuir suggested be tried in a smog-abating experiment.

### Theory Explained

"It is well known that three things must be present in order for smog to be produced," he said. "They are certain hydrocarbons, certain oxides of nitrogen and sunlight. It follows that you can avoid smog by avoiding any one of these."

Avoiding hydrocarbons would be extremely expensive, he said. Avoiding nitrogen oxides would be impossible, since nitrogen and oxygen are both found in the air. So avoiding the sun offers the best prospect.

His suggestion is that a smokescreen be laid by airplane above the smog layer in that part of the temperature inversion where the air is comparatively stable. He believes the artificial cloud will remain for a long time.

### Similar to Overcast

"In the city it would be the same as on an overcast day," he said, "and smog rarely occurs when you have an overcast."

Dr. Langmuir said the cost of laying the smokescreen would not be very large, providing the Army or Navy could be persuaded to take part in the experiment with

their smoke-laying planes. The smoke itself is produced by boiling a very fine mineral oil that costs only a few dollars a barrel, he said, and one gallon of it would cover a square mile.

"I don't offer this as a cure," he said, "but it would be a nice demonstration."

### Confers on Experiments

Dr. Langmuir, who attended the symposium as an observer, conferred with Dr. A. M. Zarem, manager of the Stanford Research Institute, over the possibility of con-

ducting some other experiments on the smog problem here.

He said he has worked out several, inexpensive experiments that he would like to see tried in Los Angeles. He is too busy to conduct the experiments himself, he said, but would be available in Schenectady for consultation and might be able to come out here briefly from time to time.

William C. Foster, president of the Manufacturing Chemists' Association, proposed formation of a permanent Presidential Advisory Committee on Air Pollution Abatement as a means of coordinating the nationwide effort to control smog.

### Luncheon Address

In an address delivered at the final luncheon of the 400 experts attending the symposium, Foster proposed that the committee be composed of Federal representatives, State and city smog abatement specialists and an industry group.

Foster said that at present there are 68 bills under consideration in 12 State Legislatures dealing with smog control, with 20 more in the Congressional hopper.

The problem is so widespread, however, there should be concerted, unified effort on city, State and Federal levels to make the fight against smog effective.

"In our considered opinion," said the spokesman for the nation's chemical manufacturers, "the formation of such a national committee sitting in an advisory capacity to the President would best serve the needs of industry, the community, and the individual taxpayer."

In a discussion devoted to the effect of air pollution on plants, Dr. J. T. Middleton,

# Definite Plan to Curb Smog Set for Grand Jury Today

## Kingsley to Present Findings in Move to Bring About Open Hearing

A "definite plan of action" for curbing the Southland smog problem will be submitted to the county grand jury today in the climax of weeks of hearings involving public officials and Air Pollution Control District personnel.

This was disclosed yesterday by John B. Kingsley, Hollywood businessman and leader of the grand jury's effort to tighten smog law enforcement. Kingsley is head of the grand jury's Committee on Governmental Honesty and Efficiency.

### Larson First Witness

The first witness at the group's climactic session on its smog study this morning will be Director Gordon P. Larson of the APCD. Larson already has spent several hours under questioning by the grand jury in sessions last week.

This afternoon Kingsley will present his "definite plan of action" before the whole grand jury, with a view to making an official finding that, first, the public welfare has been affected by the smog and, second, that there has been misfeasance, malfeasance or dereliction of duty by public officials or employees in connection with smog law enforcement or administration.

If adopted by the grand jury as a whole, these findings would be submitted to Superior Judge Harold W. Schweitzer, in charge of the body, as a basis for him to find that under Section 925a of the Penal Code an open public grand jury hearing could be called legally.

Such an open public hearing has been demanded by Superior Judge Samuel R. Blake and by spokesmen for citizen groups, notably the Pasadena Citizens' Antismog Action Committee.

Kingsley, busy yesterday interviewing scientists and other experts on smog in preparation for today's session, said his research had proved to him that the present smog law "is simple and adequate."

### Broad Definition

He said that the regulations define a violation as anything that "causes annoyance to a considerable number of persons."

It was reported Kingsley was counting on nine votes

*Los Angeles Times*

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AIR POLLUTION FOUNDATION

FINANCIAL CENTER BLDG.  
704 SOUTH SPRING ST.  
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**Air Pollution**

**FOUNDATION**

704 SOUTH SPRING STREET  
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*1955*

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## President's Report

1955

Delivered to the Trustees and Supporters of the Foundation at the Second Annual Meeting, Hotel Ambassador, November 10, 1955, held jointly with the Southern California Conference on Elimination of Air Pollution arranged by the California State Chamber of Commerce.

by Lauren B. Hitchcock

## WHAT THE AIR POLLUTION FOUNDATION IS DOING

One year ago, at our first annual meeting here, I told you of the formation of this Foundation as an independent, nonpolitical, nonprofit, fact-finding organization dedicated to establishing clearly the nature and causes of smog, thereupon to develop or encourage others to develop appropriate and workable remedies. Since at that time our staff had been organized and at work only a few months, my report was necessarily limited to a statement of what we were doing and what our plans were. Today we can report what we have done. I wish to acknowledge the help of my associates in preparing this report.

In the Statement of Policy adopted by the Board of Trustees of the Air Pollution Foundation there are eight objectives. One of these is to assemble a competent technical staff to organize and direct a broad program of cooperation, research, and public information. A second is to maintain a library of materials pertinent to the subject of air pollution. The accomplishment of both objectives was reported to you last year.

On the other six objectives we can report very substantial progress, primarily because of the hard and able work of the Foundation's scientific team and public service staff, as well as the help we have received from industry, business, government, and university leaders in air pollution work. It is from the very fact that all these men are joining in the attack, that the community is giving increasing support to this cause, that we know the job will be done.

The first of these remaining objectives is "*to determine, record, and publish what has been accomplished to date by all agencies dealing with air pollution.*" The significance of our results can only be brought into proper focus by concurrent consideration of the work of many other agencies dedicated to the solution of the air pollution problem. Accordingly, we take into account the progress of others in this report and evaluate the Foundation's results in the light of the other findings. Both the progress attained in the last year and the questions remaining to be answered are presented under four headings in our Second Technical Progress Report, No. 12 in our series of technical reports on air pollution. This report is just off the press and copies are available at this conference.

The four basic questions discussed in this report are:

1. What is smog?
2. How is smog formed?
3. What are the sources?
4. How may smog be abated?

In Report No. 12 we summarize in 143 pages all information available at the end of September, 1955 which bears on these questions. Since we are communicating with other air pollution workers on a scientific subject, much of this report is technical. However, our findings in each chapter are set forth in what seems to me to be plain English. In my report here to you today I shall only give you the high spots of this and other progress.

A second objective: *"To determine what remains to be done and to employ experts through the device of research or service contracts, who will provide information and advice for the shaping of future policies and action."* First of all we have conducted a fact-finding program consisting of crucial research investigations through contracts placed with leading research centers extending across the nation (Figure 1). Out of these has already come important evaluation of the feasibility

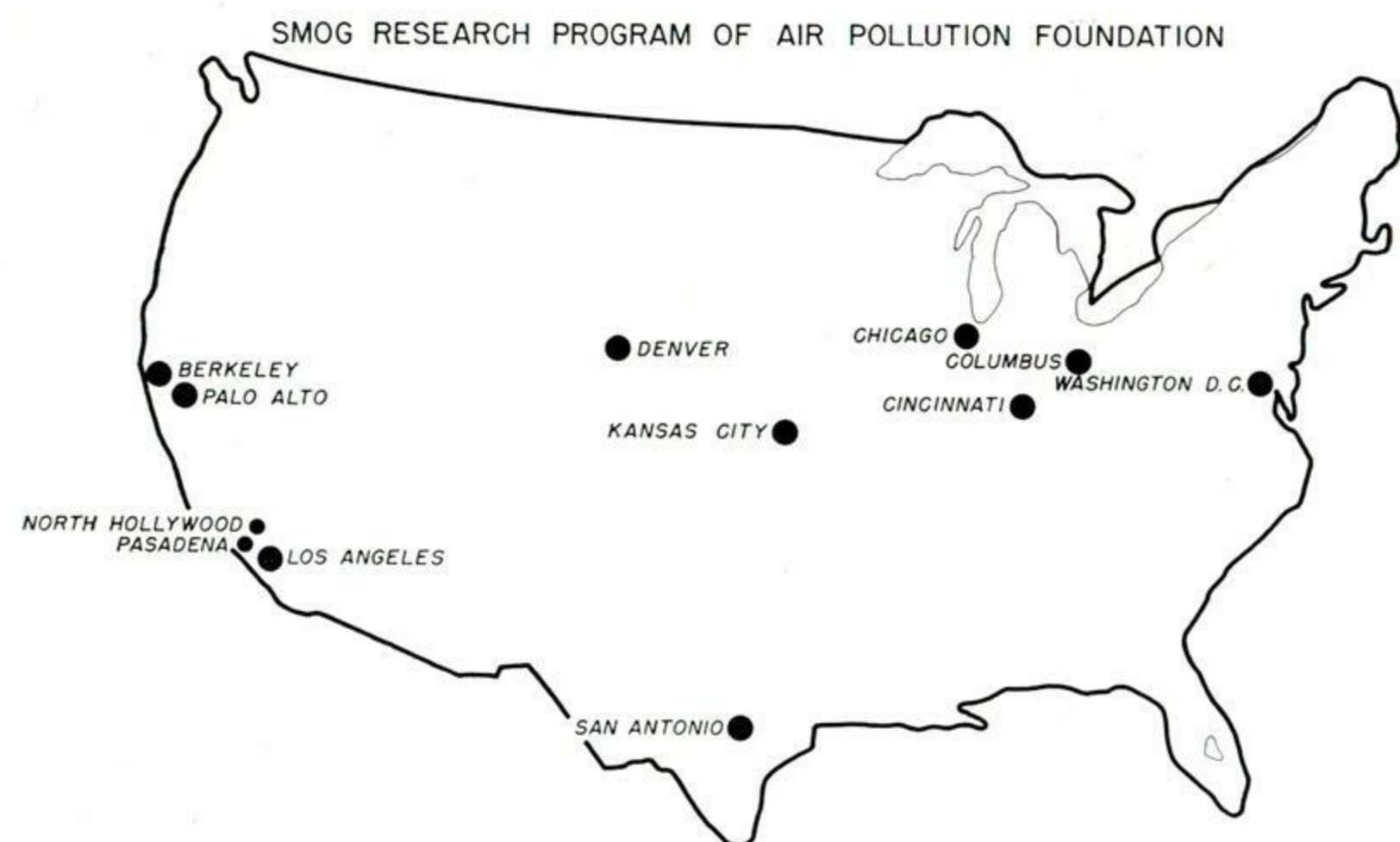


Fig. 1

Projects have been placed at Battelle Memorial Institute, (Columbus, Ohio); Armour Research Foundation, (Chicago, Illinois); Bureau of Standards, (Washington, D. C.); Midwest Research Institute, (Kansas City, Missouri); University of Denver, (Denver, Colorado); Stanford Research Institute, (Palo Alto and Pasadena, California); Berkeley Research Products, (Berkeley, California); Borman Engineering Company, (North Hollywood, California); Southwest Research Institute, (San Antonio, Texas); California Institute of Technology, (Pasadena, California) and others.

of proposed air pollution remedies. For example, we have investigated alternate motor fuels not containing tetraethyl lead, as well as alcohol-gasoline blends; the former, because it was thought that a catalytic muffler using unleaded gasoline might be easier to perfect; the latter, because of persistent reports that alcohol blends might reduce motor vehicle exhaust pollution. For reasons set forth in Report No. 12, neither offers promise.

Devices have been evaluated for the control in automobile exhaust of unburned motor fuel, broadly known to the chemist as hydrocarbons and their derivatives. These devices seek to reduce such emissions or to treat the exhaust gases after they have left the engine. We find that some of these look very hopeful.

Burning of rubbish has been identified as an important source of pollution, and the economic, workable, and nonpolluting method of collection and sanitary landfill is recommended. I believe the Foundation's clear-cut recommendations have materially advanced the program of action now underway. It cannot for practical reasons be done overnight. The Air Pollution Control District is doing everything possible to press forward on this campaign.

By development of new and continuous measuring tools for smog, the Foundation in its first year has increased man's knowledge of the problem and developed sound methods of attack.

Out of this first year of fact finding the Foundation has substantially advanced understanding and diagnosis of the air pollution problem and is now actively participating in the development and evaluation of workable remedies. Valuable suggestions are being received from some of the best minds in industrial, governmental, and university laboratories.

A third objective: *"To collect information as to what other municipal areas have done and are doing under similar circumstances; to consult with, exchange information with, and to suggest to governmental and private agencies those research activities, enforcement methods, or other matters, which have not yet been conducted or tried and which seem to offer promise of air pollution abatement, so that the efforts of all groups and individuals may be coordinated properly."* By frequent meetings with these agencies and by exchange of information and literature, the Foundation is helping to unite efforts of industry, government, and the public here and elsewhere in the struggle for cleaner air. This increases the manpower on our problem, a problem we are sharing with a growing list of cities, a problem which is still elusive. One important conclusion is the need for constant measuring of pollutants in metropolitan areas, in order that we may know definitely with what we have to contend.

A fourth objective: *"To hold technical conferences with experts and specialists working in this country or abroad on selected phases of the air pollution problem in order to facilitate and accelerate the process of finding solutions."* The Foundation has sponsored technical conferences here in Los Angeles, which has brought the help of national authorities to bear on important phases of our air pollution problem. These include conferences on motor vehicle exhaust, sanitary rubbish disposal, formation and analysis of aerosols, smog-forming chemical reactions, and relation of our weather to smog. The Foundation has accepted invitations from leading

scientific societies to conduct conferences at their meetings, at which our problem could be described and discussed. Out of such meetings comes greater help from others in this country and abroad.

The large-scale entry of the automobile industry into our problem, with all its resources of laboratories and engineering and scientific experts, is one of the most encouraging developments I can report. The decision of this great industry to come to our help was perhaps influenced to some small extent by the efforts of the Foundation to present the problem to it.

Other critical phases continue to be pushed forward by the oil industry and the steel industry. The cooperation we are receiving from these groups and their technical leaders is invaluable.

This summer, at the request of the Board of Trustees, seven authorities on various aspects of the Los Angeles smog problem agreed to serve as a Technical Advisory Committee on the Foundation's research program. The assistance of these outstanding scientists and engineers is very welcome. A list of members of this committee appears on p. 4.

Another important objective is "to publish current information by the most appropriate means on all phases of air pollution and its abatement." The twelve technical reports published to date constitute in total 1,120 pages of basic information dealing with primary aspects of modern urban air pollution in the Los Angeles area. Many of the findings will inevitably have application in other communities. Copies of all reports have been furnished not only to you, our trustees and contributors, but to all leading air pollution workers in this country and abroad, to scientific societies, and to the principal libraries in this country. These reports have been favorably reviewed in national magazines. Requests for them are being received not only from people in Los Angeles County but from municipal and state officials in California and from others over the country. Over 8,000 copies of these reports have been printed.

At the same time the Foundation has been aware of its obligation to accurately inform the public. Valid information has been supplied through all media, including the press, radio, and television. We publish a monthly newsletter. We have sound motion pictures and color slide collections as visual aids. In response to invitations from many civic and neighborhood organizations in Los Angeles County, we set up a speakers' bureau to provide competent speakers. Trustees and supporters of the Foundation have been most cooperative in providing able men from their own organizations for this bureau.

At the request of the local Public Affairs Committee of Kiwanis International with 110 clubs in the Los Angeles Basin, the Foundation has cooperated in their public-spirited effort to inform the public accurately and impartially about the nature and causes of smog and the progress which is being made in developing remedies. We stand ready to assist other groups if called upon. We are cooperating with the Air Pollution Control District and the State Chamber of Commerce in this meeting today.

## Purposes to Which Funds Have Been Allocated

Despite the generosity of the contributors who are supporting us in this pioneering attack, the magnitude of the problem has required severe rationing of funds among a few of the most urgent projects, particularly those not being done elsewhere or done adequately. Figure 2 shows where our dollar went. Note that 74 cents goes for direct research expenses. General and administrative expenses amount to only 16 cents or 22 per cent of direct research as compared with 80 to 120 per cent typical of most industrial research.

Our Finance Committee, assisted by many civic leaders, serve without compensation in voluntary fund raising for the Foundation.

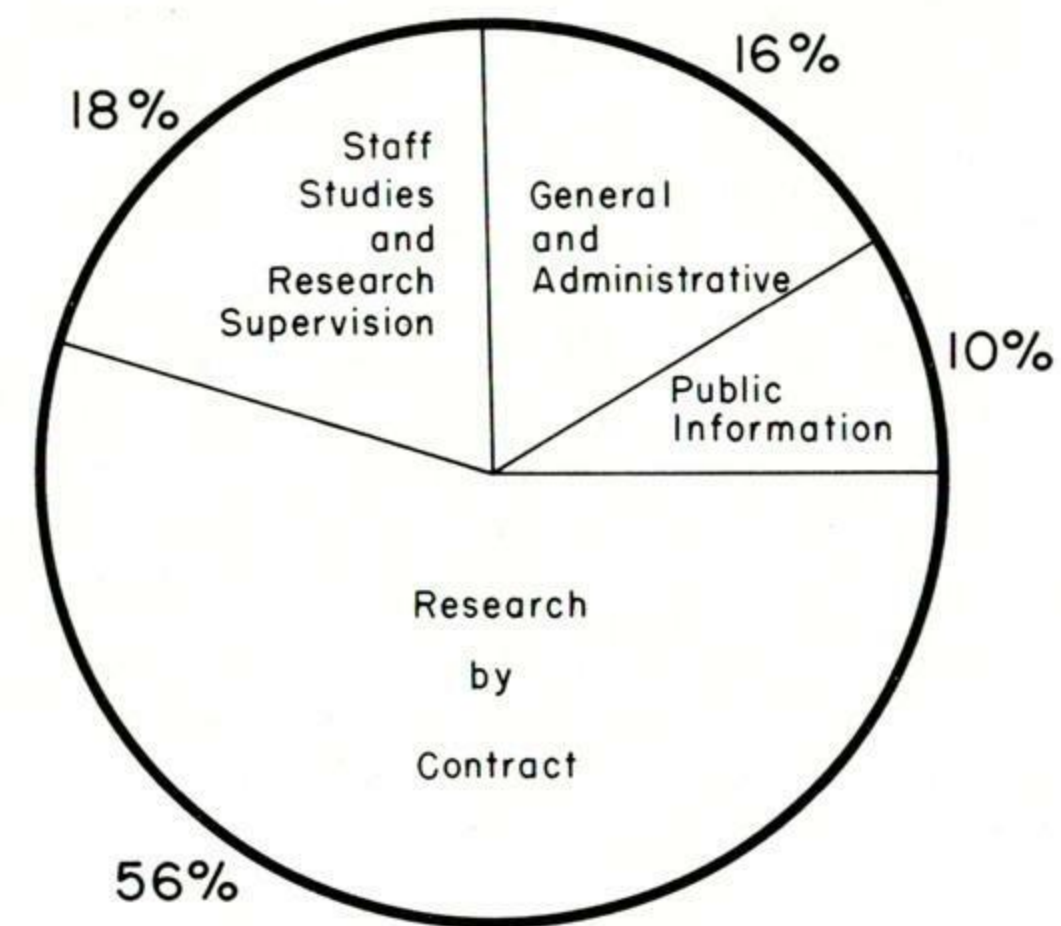
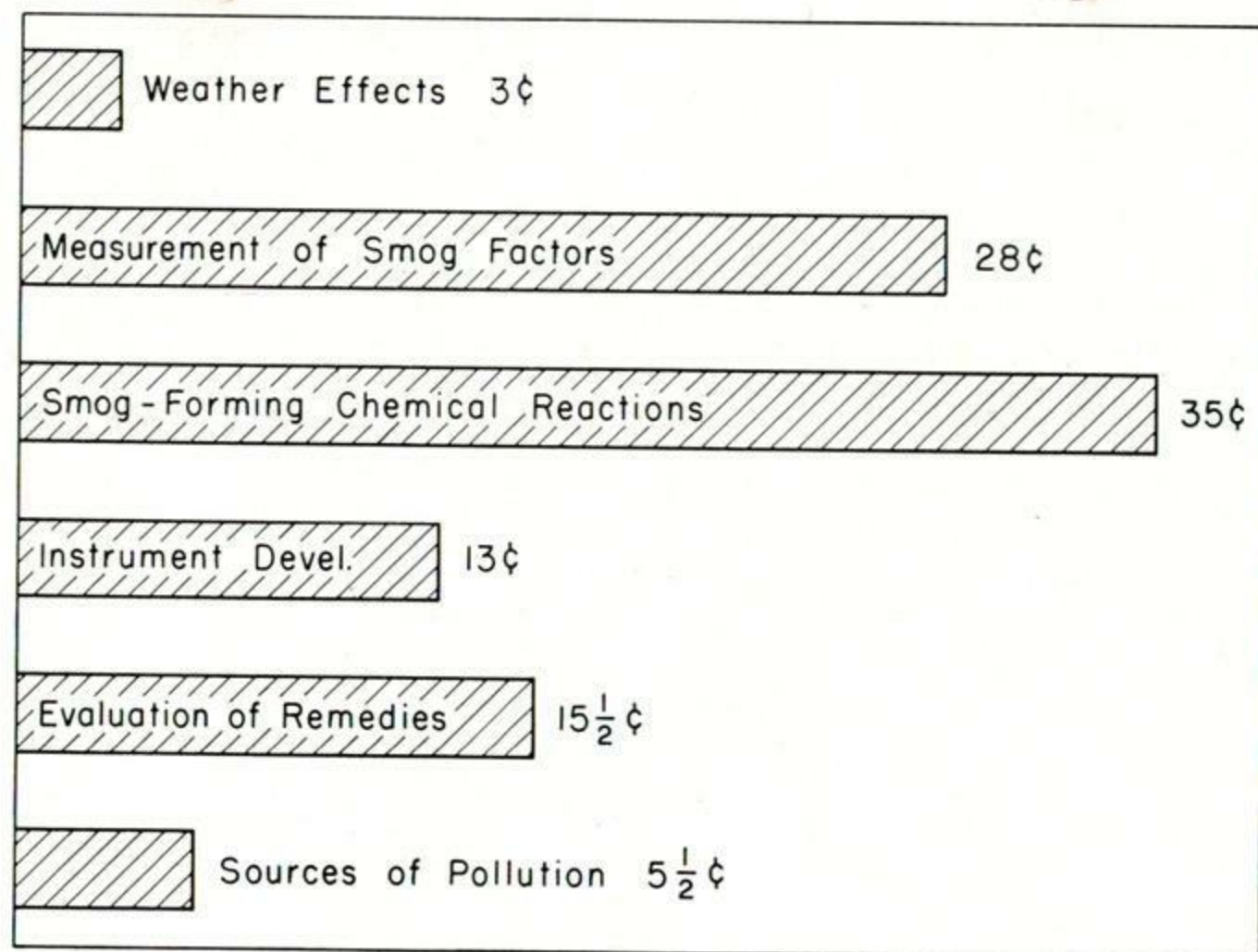


Fig. 2  
Allocation of the Budget

Our research dollar has been divided among the main purposes shown in Figure 3. These subjects are most closely concerned with our smog problem and we believe the way in which our research dollar is divided among these purposes is roughly equivalent to their relative importance. Our 1956 goal is \$750,000. Many of our contributors have already renewed their annual subscriptions. Remaining renewals are anticipated, based on the experience of last year. Even so, \$200,000 of new money must be raised, primarily from sources which have not yet contributed. Favorable consideration is now being given by some of these groups. It is most important that our goal be reached.



**Fig. 3**  
Where our Research Dollar Goes

## Summary of the Los Angeles Smog Problem

I have touched on some of our principal accomplishments and cited a very few examples. I know that you want to hear answers to such questions as "What have we found out?" and "Are we any nearer to solving the smog problem?" The answer to the second question is "yes" and I shall do my best in this brief report to tell you why.

First, I will tell you what we have found out as a result of the work described above; second, why we are nearer to a solution; and third, the nature of the solution as it is now taking shape.

It is inevitable that in bringing the definition of the Los Angeles smog problem up to date some of the conclusions will seem familiar, particularly to those who have followed air pollution work in Los Angeles for several years. Many of these conclusions derive from the work of the Air Pollution Control District, Professor Haagen-Smit at California Institute of Technology, Stanford Research Institute, and others. This definition is the result of critical selection of facts and evaluation of many differing theories which characterized the vague understanding of the problem as of two years ago. Those of you who have followed this battle more closely may recognize a firming up of certain points, and the absence of other theories and supposed remedies.

The Los Angeles smog problem is a direct consequence of air pollutants arising from man's activities. Operation of motor vehicles, factories, and rubbish burners,

to name three principal categories, contribute a great variety of pollutants in gas, liquid, or solid form. Some of these are visible at the point of origin, and some are not. None of these pollutants at the point of origin possess the characteristics of smog, which we will define shortly.

While our smog problem is a direct consequence of man-made pollution, meteorological and topographical influences contribute to the undesirable effects, although they do not of themselves cause these effects. Los Angeles did not have a smog problem of any moment prior to around 1940, yet the meteorology and topography of this area have undergone no significant change as far back as there is any record. The quantity and variety of pollutants, being a direct consequence of man's activities, increase with the number of motor vehicles, factories, and tonnage of refuse burned.

About the beginning of World War II man's activities in the Los Angeles Basin resulted in a daily production of pollution which began to exceed the natural dissipating capacity of the environment, particularly on those days when the inversion was low and the winds were low. Man's activities had always produced pollution, but up until then, while we had had the same cycles of low inversions and low winds, objectionable concentrations did not arise because the emissions were not excessive. The same opportunities for escape of pollution exist today as existed then, no worse or no better, but the daily production of pollutants has increased enormously so that their concentrations are much higher than they used to be.

## Methods of Attack

Two obvious approaches to the problem have received a vast amount of speculative consideration by both scientists and laymen. The first approach is to find some way of changing our meteorological or topographical features. The second is to reduce our pollutants at their points of origin. Another way is treatment of the atmosphere, as by neutralization or dilution.

Profound studies by properly qualified meteorologists and physicists have failed thus far to reveal any likelihood that man can economically change either meteorological or topographical features sufficiently to have any significant effect on our air pollution problem. The quantities of energy associated with these natural influences appear to be far beyond any resources of man of which we have knowledge at present.

The second approach, to reduce pollutants at their sources, is the only approach which has resulted in any progress in abating air pollution here or elsewhere. Beginning about eight years ago, various control devices were installed. These controls include, for example, sulfur recovery systems, electrostatic precipitators, bag filters and other devices for collecting some of the dusts, floating roofs on gasoline storage tanks, closed recovery systems in oil refineries, and many others. These installations have been made either voluntarily by the parties concerned or as a direct consequence of regulations of the Air Pollution Control District, which estimates that in total these devices are keeping out of our air today about 1,100 tons per day of pollutants.

In metropolitan areas with better natural ventilation, this achievement would undoubtedly have been far more significant. One can only speculate on what our smog problem here would be like today if this progress had not been made. That it is inadequate is due to the tremendous continuing growth here in man's activities, a growth unequalled elsewhere in this country. The continuation of severe smog attacks shows that either the pollutants which have been controlled are not the ones which contribute substantially to our smog effects, or if they are, that they have not been reduced sufficiently.

### Are Some Pollutants More Harmful?

This brings up a third approach to a solution of our smog problem, which is really a special case under the second method of reducing pollutants at their points of origin. In this third approach it is assumed that some pollutants are much worse than others. By the same token it is assumed that there are some pollutants which are relatively innocuous. This, of course, has been the traditional approach to development of our sanitary water supplies, which contain innocuous contaminants but in which the harmful agents are controlled to levels which have been carefully determined to be tolerable.

This third approach has in its favor the possibility that the control of only harmful air pollutants would be considerably less expensive to the community; for to attempt to solve our problem by reducing *all* pollutants to, let us say, 1940 levels would require the development and installation of a vastly greater amount of equipment, hence take more time and money. The third approach assumes that the harmful pollutants can be identified and that devices can be developed and installed specifically for these pollutants in less time and at less expense.

There is evidence that some of our numerous pollutants here are more harmful than others. It therefore becomes apparent upon brief reflection that we must have some yardstick of harmfulness. We know of no single pollutant entering our atmosphere which is known to be harmful to man at the highest concentrations found here. Ozone, which has come to be the index of our smog intensity, does not originate in any of man's activities but forms in our atmosphere as a consequence of complex photochemical reactions involving certain of our pollutants. Neither has anyone been able to find among our myriad pollution sources any compounds which, as emitted, produce the specific forms of eye irritation or plant damage characteristic of Los Angeles smog in the concentrations measured in the atmosphere. Again, therefore, these agents are formed in our atmosphere subsequent to the point of escape.

Pursuing this third approach then, one wishes to know which pollutants take part in the reactions which produce the harmful or undesirable effects.

Let us at this point offer a definition of Los Angeles smog: it is an atmospheric condition which can be defined so far only in terms of its identifiable effects. These are (1) eye irritation; (2) reduced visibility; (3) oxidant formation, including ozone; and (4) plant damage. This is admittedly a loose and arbitrary definition, but we know of no better one at present. It distinguishes between gross air pollution

on the one hand and the condition which develops objectionable effects. It is useful only to the extent that it provides some basis for selecting harmful or undesirable pollutants from the great variety we have. To put it another way, if by removing certain pollutants we could prevent the above-named effects, we would say that we had found the smog formers.

### Principal Pollutants

In pursuing the third approach, it seems logical to begin with an inventory of our atmosphere. An inventory of pollutants at their points of origin is also pertinent. Both inventories are needed in taking either the second or third approach. Much work has been done in an effort to develop these data. While much more remains to be done, estimates of the composition and quantities of sources, reinforced by extensive air sampling, indicate that the principal initial pollutants arising from man's activities include these:

- Carbon monoxide
- Organic Compounds
  - Hydrocarbons
  - Partially oxidized hydrocarbons
  - Miscellaneous organics from partial combustion of rubbish
  - Miscellaneous solvents (dry cleaning, paint thinners)
- Oxides of nitrogen
- Oxides of sulfur
- Particulate matter
  - Carbon (soot)
  - Dust (silicates, carbonates, sulfates, etc.)
  - Ash (great variety of metallic oxides)
  - High molecular weight organic polymers, tars, finely divided particles from the abrasion of tires, etc.
- Water vapor
- Carbon dioxide

In some of these categories there are a great variety of compounds. Water and carbon dioxide are considered to be innocuous. Carbon monoxide is not found in our atmosphere at concentrations remotely approaching toxic levels published by public health authorities, nor has it been shown yet to take part in atmospheric reactions. Accordingly, it is set aside tentatively as harmless under presently known conditions prevailing here.

### Particulate Matter

Particulate matter is suspect not only because of its more obvious role in forming aerosols and reducing visibility, but because of the growing evidence that sub-micron\* particles may collect gaseous and liquid pollutants existing at nontoxic

\*A micron is about 1/25,000 of an inch; the average human hair is about 70 microns thick.

levels, concentrate them, and transport them into the deeper portions of the respiratory system. Some metallic oxides existing normally in our particulate matter are also capable of catalyzing oxidation reactions, including the oxidation of sulfur dioxide to sulfur trioxide.

Analyses of our particulate matter by the U. S. Public Health Service, as reported by Chambers, are preliminary but indicate that the sulfate and nitrate content here is higher than in any of thirty other American cities sampled. Because of the obvious contribution to grime and smoke, let alone the unproven but suspected effects, it is generally conceded that particulate matter should be the object of more complete control. Despite the efforts of the Air Pollution Control District (APCD) and others, one important source of particulate matter, namely the burning of rubbish, remains largely uncontrolled mainly because of political factors. APCD regulations exist, the purpose of which is to limit the rate at which the particulate matter may be emitted as defined either by grains per cubic foot of stack gases or by opacity as estimated by the Ringelmann chart. Burning of refuse has been estimated by APCD to account for as much as 65 per cent of the "smoke" in Los Angeles.

The control of particulate matter is subject to the same approach as air pollution in general, in that one may strive to control *all* particulate matter at the source, or to identify harmful particulates and seek to control these selectively. Again, we are in need of much more information. Except for the reduction of visibility, there is inadequate evidence so far that particulate matter contributes to smog as defined by its manifestations.

## Sulfur

Sulfur dioxide itself is found in our atmosphere normally at lower levels than found in some other large cities. Plant damage due to smog is definitely distinguishable from that due to oxides of sulfur and sulfuric acid. Data on the concentration of sulfur trioxide and sulfuric acid in our atmosphere are virtually nonexistent. There is no evidence that sulfur dioxide in the maximum concentrations ever reported here causes any eye irritation. There is no evidence that oxides of sulfur or sulfuric acid increase measurements of oxidants or ozone. Sulfur dioxide reduces the oxidant reading by potassium iodide. In short, at the concentrations found in our atmosphere in Los Angeles, there is no evidence that sulfur dioxide exerts any harmful effects despite the popular impression that "sulfur is a culprit," a view traceable to incidents in other cities where at times sulfur oxides or hydrogen sulfide have been found at higher concentrations and associated with acute air pollution effects. The extent to which sulfur compounds in the Los Angeles atmosphere are harmful is yet to be established.

## Organic Compounds

Among the so-called principal pollutants listed above, there remain organic compounds and oxides of nitrogen. These include all the hydrocarbons\* found in natural

\*Hydrocarbons are compounds of hydrogen and carbon and are the principal substances in petroleum and petroleum products, such as gasoline and oil.

gas, and petroleum and petroleum products, beginning with methane. Such compounds and their derivatives enter our atmosphere from gas distribution systems; from the production, refining, and marketing of petroleum products; and from the incomplete combustion of these products; also, from the vaporization and/or atomization of heavier products such as lubricating oils; and by evaporation from carburetors and motor vehicle fuel tanks. Depending upon air-fuel ratios and upon normal operating temperatures and design characteristics of the great multitude of combustion devices which man operates today, both unburned and partially oxidized fuel escapes to the atmosphere.

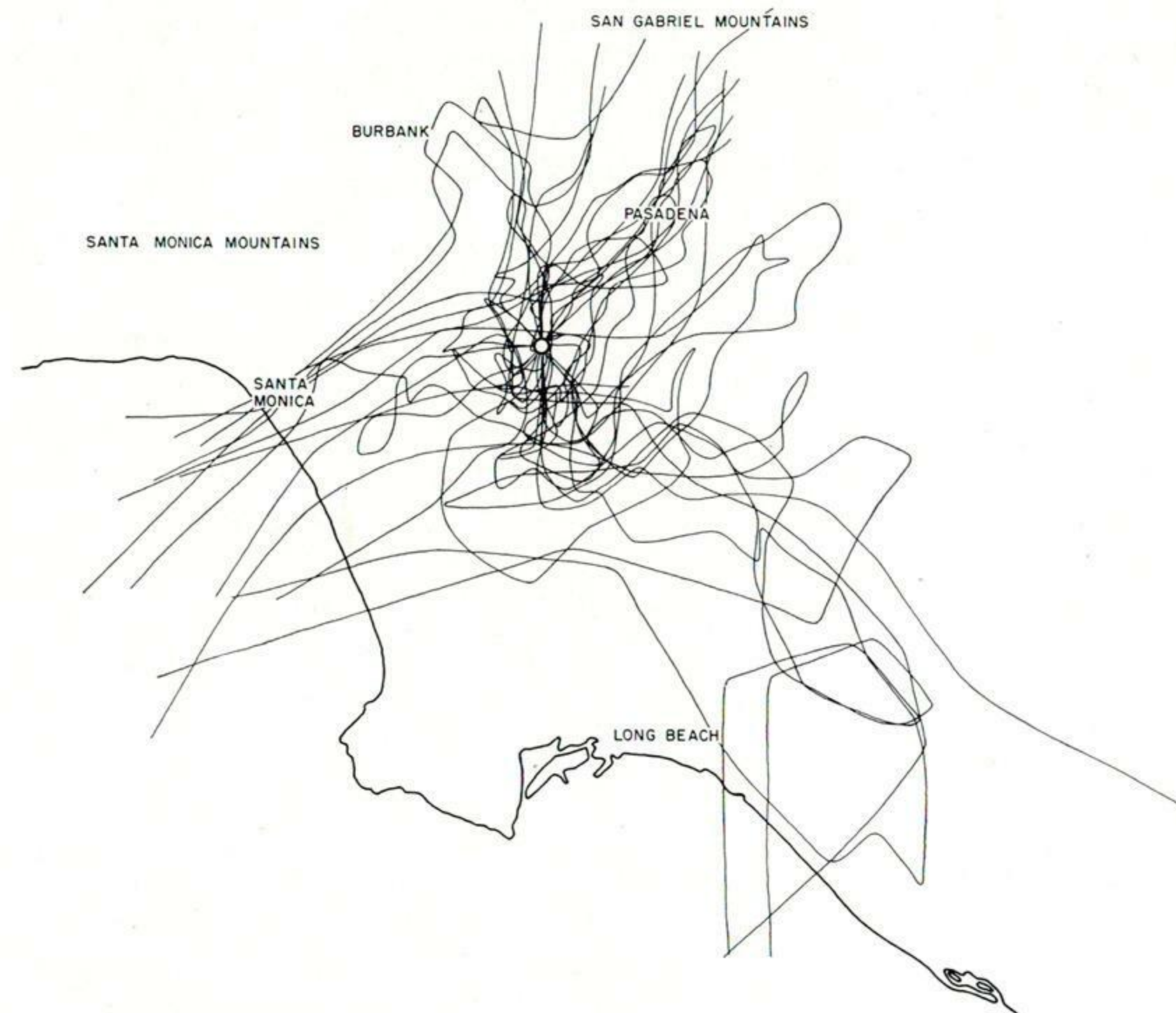
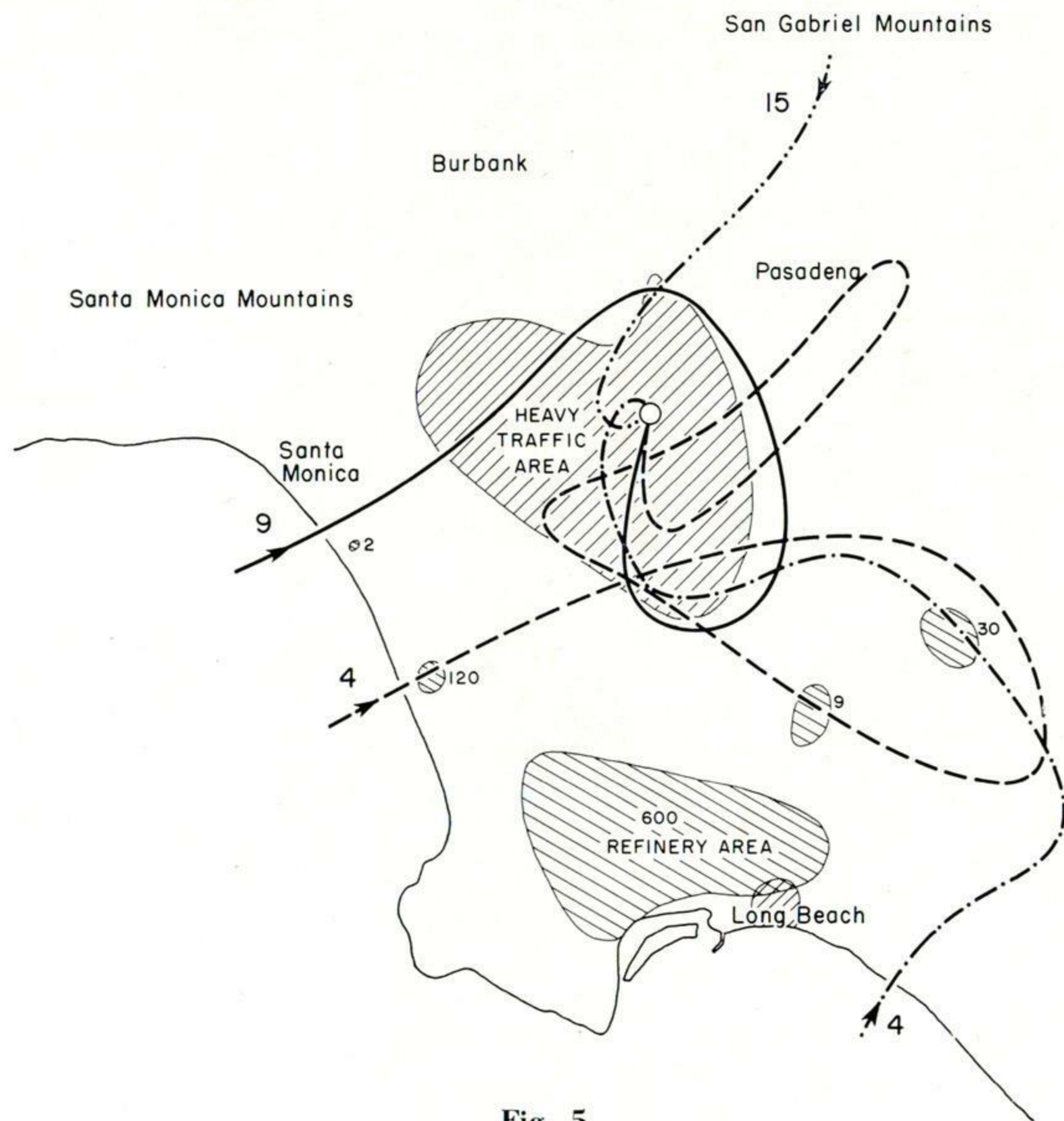


Fig. 4

Paths taken by polluted air to downtown Los Angeles on thirty-two smoggy days when hydrocarbon concentrations downtown exceeded 0.5 parts per million of air. This confused jumble of "spaghetti" is clarified by the schematic representation in Figure 5.



**Fig. 5**

Schematic summary of thirty-two wind paths from Figure 4, with number of individual trajectories represented shown by a numeral near beginning of each of the four representative paths shown. Note that on fifteen days hydrocarbons in downtown Los Angeles were picked up by air moving in from the San Gabriel Mountains and on nine other days from the coast near Santa Monica, a total of twenty-four, or 75 per cent of the thirty-two smog days when the air traversed heavy traffic areas and no refinery areas; on the other eight days the paths led near enough to refineries to be influenced by them, although none passed directly over the area of concentrated refineries in the south. In all thirty-two cases wind paths traversed heavy traffic areas in arriving at the downtown test station at Fifth and Spring Streets. Details of these findings are included in Report No. 13 now in preparation.

In addition to the galaxy of hydrocarbons and hydrocarbon derivatives connected with the production and use of commercial fuels, there are organic compounds resulting from the incomplete combustion of miscellaneous refuse. While but a few of these organic compounds have been identified, it is known that they include phenols, acetone, methanol, organic acids and tars, somewhat analogous to the products of wood distillation.

The consumption of miscellaneous solvents, as in dry cleaning or in paint thinners in the Los Angeles area, must closely approximate the input of these compounds to our atmosphere. Among such solvents would be found carbon tetrachloride, trichloroethylene, tetrachloroethylene, benzene, monochloro benzene, solvent naphthas, and turpentine.

Haagen-Smit originally, and now several other workers, have produced oxidant and/or ozone by irradiating mixtures of single organic compounds with nitrogen dioxide and oxygen, in which the organic compound has been any one of a number of different saturated hydrocarbons, olefins, diolefins, straight chain or branched molecules, aldehydes, alcohols, ketones, and complex mixtures of organic compounds such as commercial gasoline as well as auto exhaust. The capacity for oxidant or ozone formation may vary widely from one organic molecule to another. The amount of oxidant and/or ozone formed is also dependent upon the starting concentration of nitrogen dioxide and upon the intensity and time of radiation.

### Reduction of Selected Organic Compounds

In the light of these experiments and others carried out along similar lines, observed oxidant and ozone values in the Los Angeles atmosphere can be accounted for qualitatively in terms of observed concentrations of organic compounds and nitrogen dioxide, even though we do not yet understand the complex reaction mechanisms. We cannot yet say that the reduction or the elimination of certain classes of organic compounds, such as gasoline hydrocarbons, would cause a proportionate, or any, reduction in ozone, because it is entirely possible in our present state of knowledge that the remaining organic matter plus the unchanged nitrogen dioxide would still produce as much ozone as before. Conceivably, reduction of nitrogen oxides might have a more significant effect in reducing smog than reduction of organic compounds, particularly if the latter reduction were confined to certain classes of compounds.

So far we have been discussing one smog effect, namely oxidant-ozone. The experimental production of eye irritation, plant damage, and reduced visibility by irradiation of organic compounds and nitrogen oxides at experienced concentrations is far less extensively reported in the literature.

There are indications that auto exhaust blended from all four operating cycles, and hydrocarbons at concentrations close to those estimated for the Los Angeles atmosphere during heavy smog periods, when irradiated, will produce both eye irritation and plant damage. There are indications that the same may be true of gasoline vapors themselves. We do not know what the compounds are which irritate

eyes or damage plants, nor do we know from which hydrocarbons or other organic compounds they are formed. Ozonated olefins produce typical smog damage to plants in controlled laboratory tests. Consequently, we cannot say that reducing the hydrocarbon content of auto exhaust by 50 per cent or any other fraction will or will not reduce eye irritation and plant damage. If what might be termed "gasoline-economizer" devices are developed, which would reduce the hydrocarbon content in auto exhaust on an over-all average by 50 per cent for example, at the present time we can only say that this would effect fuel savings of about 3 per cent, based on the total fuel consumption of the average motor vehicle. Based on an average consumption of two gallons per day, this should represent a savings of about 20 gallons per car per year, or about \$6. Some people feel that the cost of a control device would be justified by fuel economy alone. Multiplied by over two million vehicles, this would amount to keeping out of our air something like 500 tons of gasoline vapors per day. With respect to smog effects, however, without control of oxides of nitrogen at the same time and without control of the very substantial remainder of the organic compounds, we can see little basis at present for the conclusion that a significant reduction in smog is to be expected by the use of a device which will reduce hydrocarbons from automobile exhaust by 50 per cent.

This statement will doubtless seem unreasonable to some people and disappointing to a great many. It is a statement based on lack of data rather than on the basis of facts in hand. This is why we feel that "chamber" experiments (see page 22) are urgently needed in order that the smog-forming potential of actual sources, singly and in combination, may be tested, as well as the effects of proposed control devices for these sources. Experimentation in this way could forestall the premature adoption of devices which might cost the community many millions of dollars without commensurate gains.

### Other Data Needed

We believe that additional information is essential as to the variation of various pollutants with respect to both time and place. We have no data showing the concentrations of organic compounds and oxides of nitrogen, for example, in the immediate proximity of heavy traffic arteries. Our data so far are limited to a few scattered monitoring stations where in all likelihood we have measured residual values after both chemical reaction and dispersion have taken place. Similar comments may be made with respect to composition and concentrations of other pollution sources, such as industrial stacks. Considerable progress has been made in developing methods of analysis, particularly in the direction which will permit continuous automatic recording for monitoring purposes. Much, however, remains to be done. Without sufficiently accurate and dependable methods of analysis and monitoring, we cannot know with what we have to contend.

The many uncertainties on what seem to us crucial questions, indicated throughout the foregoing discussion, are the basis of the numerous research projects we propose. Any practical estimate of the cost of such research now in sight far exceeds our own financial resources. We hope that other agencies will recognize the importance of these research projects so that more rapid progress may be made.

## How Much Progress Has Been Made?

Because the nature and causes of smog are now more clearly understood and more generally agreed to, and because, therefore, the types of remedies are beginning to take shape at least in a general way, important progress has been made and is being made despite the fact that smog is still with us and may be getting worse. We know now what our principal targets are. We are building an arsenal of weapons in the form of scientific instruments and methods of analysis. We can begin to call our shots. Those of you who were close to the situation two years ago I think will agree that progress has been made. The Foundation has been a part, but only a part, of this progress.

## What is the Shape of Remedies to Come?

Recognizing that predictions are hazardous, certain probabilities stand out with respect to the types of remedies likely to prove successful. These are:

1. There is little likelihood that any practical changes in the meteorology or topography of the Los Angeles Basin would be effective in reducing smog. The quantities of energy required to transform or modify these natural influences appear to be far beyond any resources of man of which we have knowledge at present.
2. Control of the effluents from the burning of rubbish can well be accomplished by banning this archaic practice. Cut-and-fill disposal may offer effective relief for some years, but eventually improved designs for municipal large-scale incinerators will probably have to be developed. Adequate designs await further research.
3. The reduction of air-borne particles from industrial stacks will have to be attacked from two different standpoints. Improved efficiency of combustion could eliminate organic aerosols, but inorganic materials will have to be removed from the stack gases by physical or chemical means. Both approaches require further research.
4. If sulfur dioxide emissions are found to require further reduction, the most effective attack may well be elimination of sulfur from the fuel. Suitable methods, particularly for residual fuel oil, are not currently available.
5. Further abatement of hydrocarbon and solvent losses by evaporation means an extension of vapor recovery or combustion systems. More engineering research will be required to develop economic equipment for this purpose.
6. Reduction of the hydrocarbon emissions from the exhaust of internal-combustion engines awaits an effective method. In the case of spark-ignited engines, four areas show promise: fuel cutoff devices operating during deceleration, exhaust converters (either catalytic or noncatalytic), fuel injection, and improved maintenance. It may well be that ultimately some combination of the above may be most suitable. In the first three areas adequate devices are not yet developed, although automobiles using fuel injection could well appear in 1957. Such designs would obviate the need for a fuel cutoff device. Even so, exhaust converters would still be needed.



The quantitative value of improved maintenance has not yet been determined. Whether governmental action in this regard will be desirable depends on the magnitude of hydrocarbon reduction that could be achieved and the nature of other devices to be used.

Slightly different problems are presented by the diesel engine, but these should be amenable to further research. Such work should be initiated at once. If the gas turbine engine becomes a reality for automobiles, other problems may develop. It is assumed that the automobile manufacturers will anticipate this possibility.

7. The one area in which it is difficult to envision an effective reduction device is for oxides of nitrogen, whether they are emitted from automobiles, diesels, or industrial stacks. Obviously, a concerted research study is badly needed.

Implicit in this picture of remedies to come is the need for stepped-up engineering and development. Above all, Los Angeles needs an air resource test facility. Plans are now being drawn up by the Department of Engineering at the University of California at Los Angeles with the cooperation of the Air Pollution Control District and the Air Pollution Foundation. Such a facility is intended to provide accurate and reliable information as to the importance of various atmospheric pollutants and the consequences of reducing or eliminating any one or more of them. Of great importance to us would be our ability to test in this facility the various remedies that have been and will be suggested. In this way the public would be assured that any remedy recommended to it or required of it was workable, worthwhile, and economical. **Among all the jobs that lie ahead of us on the road toward victory over smog, the construction of this air resource facility we consider foremost.**

## Can the Smog Problem be Solved?

We are asked many times by our friends, by the Foundation's supporters, and the public in general if we really believe that the smog problem can and will be solved. If the staff of the Air Pollution Foundation believed that the answer to this question were anything but "Yes!" they would shut up shop and change jobs. No reputable scientist willingly associates himself with any project that he believes will result in failure.

But to say that the solution will be easy and quick is another matter. There are two technical factors involved in solving the Los Angeles smog problem. These are (1) lack of information, and (2) lack of adequate abatement methods. To solve these problems, we must (1) establish limits for the important pollutants and (2) develop control mechanisms based on these facts. We are currently engaged in finding and assembling the necessary factual information. With this as a base, we can develop abatement procedures just as surely as scientific men can develop jet aircraft or man-made satellites.

But there is a third problem — one not under the control of the scientists. This is the willingness of the community — which includes business, industry, the public, and government — to spend the necessary money and to accept the necessary controls. Nothing worthwhile is ever free.

Now let's get specific! Evidence is piling up that two major smog sources not now controlled are incinerator effluents and the hydrocarbons from automobile exhaust. We, along with others, are developing solutions. We *know* what to do about the incinerator problem; now it is up to the community to accept the solution.

Work on the development of a device to reduce hydrocarbons in automobile exhaust is underway in many laboratories. A device to reduce oxides of nitrogen may also have to be developed. Industry will have to tool up to manufacture these. But, will industry supply the money if it is not certain that the products will be effective and will sell? We are developing the means to test these devices so that we can assure industry and the public that they will be effective.

Let us assume these tests are affirmative. Then comes community action. The devices will cost money—perhaps \$15, perhaps \$150, for each car owner. The devices may have to be inspected twice a year. This means an inspection system, which means higher taxes and further inconvenience to the motorist. So, in this hypothetical but highly probable case, the alleviation of smog will mean that the community must accept direct costs for installation and maintenance, the indirect cost of inspection, and a measure of inconvenience. But again, if we did not believe the community wants to get rid of smog badly enough to do these things, we wouldn't be here.

Likewise, industry may have to develop and install additional devices for the reduction of hydrocarbons, nitrogen oxides, and possibly other pollutants. We think the willingness of this part of our community to spend the necessary money and to accept the necessary procedures has been demonstrated and may be relied upon in the future.

But even if remedies which have been suggested do not completely solve the problem, the remaining difficulties are amenable to the same tactics:

- Get the facts.
- Develop and test abatement devices and methods.
- Get public acceptance.

This is the Foundation's program; we believe it will be effective.

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*"The scientist should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances; have no favorite hypothesis; be of no school; in doctrine have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of nature."*

... Michael Faraday

## Statement of Policy

### Purpose of the Foundation

An independent, nonprofit corporation has been established for the following purposes:

1. To cooperate with and to assist in coordinating the efforts of governmental agencies, educational institutions, specialized research groups, and medical, legal, and other technologists, so that every phase of air pollution shall be the object of careful study and constructive, remedial action.
2. To provide for research on those phases of the problem not already undertaken or completed by other agencies.
3. To inform the public periodically concerning the nature and extent of air pollution, progress made in its elimination, and obstacles to such elimination.

### Organization of the Foundation

The Board of Trustees of the Foundation is composed of business, professional, and industrial leaders with records of conspicuous public service. About one-third are representatives of industrial enterprises which are or may be contributors in some degree to air pollution. The principal reason for their membership on the Board, in addition to their recognized standing in the community, is to make certain that they will be parties to all facts and evidence brought to light on the problem, so that they and their colleagues in like enterprises can continue to devote their best efforts toward the abatement of air pollution.

As a matter of policy, not more than one representative of a given industry serves on the Board at a time. Trustees serve without compensation, nor do they contribute financially to the Foundation. Less than half of the Trustees represent companies or organizations which are providing financial support, and most of these do not contribute to air pollution.

The funds of the Foundation are donated by about 150 different enterprises, trade associations, banks, insurance companies, and industries, representing a cross section of the community. Few of the donors are or may be contributing to air pollution, and less than one-half of total funds received come from all such sources combined.

Financial contributions are unrestricted as to purpose and convey no rights to the donors other than to receive copies of reports, findings, and recommendations. Neither membership on the Board of Trustees nor donation of funds can in any way obtain privileged treatment in connection with responsibility for air pollution or its abatement. The work of the Foundation will be conducted with complete objectivity at all times and its findings are made impartially.

A Managing Director and a limited staff of experts will conduct the day-to-day activities of the Foundation under the general supervision of the Board of Trustees.

## What the Foundation Proposes to Do

1. To assemble a competent technical staff to organize and direct a broad program of cooperation, research, and public information.
2. To determine, record, and publish what has been accomplished to date by all agencies dealing with air pollution.
3. To determine what remains to be done and to employ experts through the device of research or service contracts, who will provide information and advice for the shaping of future policies and action.
4. To collect information as to what other municipal areas have done and are doing under similar circumstances.
5. To maintain a library of materials pertinent to the subject of air pollution.
6. To consult with, exchange information with, and to suggest to governmental and private agencies those research activities, enforcement methods, or other matters, which have not yet been conducted or tried and which seem to offer promise of air pollution abatement, so that the efforts of all groups and individuals may be coordinated properly.
7. To hold technical conferences with experts and specialists working in this country or abroad on selected phases of the air pollution problem in order to facilitate and accelerate the process of finding solutions.
8. To publish current information by the most appropriate means on all phases of air pollution and its abatement.

## What the Foundation Does Not Propose to Do

1. It will not duplicate services already rendered by governmental or private agencies.
2. It will not conduct research activities directly, unless it appears clear that no existing agency can conduct them as advantageously.
3. It will not expend funds entrusted to it for the construction or equipping of Foundation laboratories that will duplicate facilities already available.
4. It will not hold public hearings for the purpose of receiving complaints, or in any way substitute for governmental agencies now charged with responsibility for certain phases of the air pollution problem.
5. It will not offer any immediate or ready solution for a very complicated, long-range problem.

## How the Work of the Foundation May Be Assisted

Those who believe that the proposed activities of this independent Foundation can be of help may assist in this work by making contributions payable to the AIR POLLUTION FOUNDATION, addressed to its headquarters at 704 South Spring Street, Los Angeles 14, California.

Contributions from governmental organizations, business or industrial enterprises, and from private citizens will be welcomed by those in charge of its program.

## A Word of Caution . . . and an Invitation

The smog-free skies of an earlier day in California cannot be brought back immediately by any endeavor, however resolute the attempt, or through any quick expenditure of funds; they can be restored over a reasonable time by diligent and honest fact finding, by wise and effective action.

Air pollution is now recognized as a national problem. The fundamental contributions which the Foundation is making toward the solution of urban air pollution are attracting increasing national attention.

### Assumptions Made by the Foundation

1. That the problem of air pollution is one of the most serious confronting urban areas in California and elsewhere; that it is worthy of the best efforts of everyone concerned; and that it calls for the expenditure of whatever funds are needed for its solution.
2. That the air pollution problem is not new and is generally increasing.
3. That geographical and meteorological features often contribute materially to the air pollution problem, especially in the Southern California area.
4. That every additional person or industrial enterprise locating in this area potentially adds to the problem.
5. That much excellent work has been done by governmental and private agencies to reduce air pollution, and by the press to keep the public informed; that the public should be informed of all significant phases of the problem.
6. That further information must be obtained and additional action taken before the air pollution problem can be brought under proper control.
7. That there is no quick or easy solution to the problem, no matter what funds should be spent immediately or what laws should be invoked. There is an understandable tendency to oversimplify this problem and to insist that its obvious seriousness and urgency somehow must expedite its solution.
8. That the control of emission of particular gases, fumes, or dusts may not alone solve the problem. (Some of these pollutants, believed to be harmless or of minor importance individually, may in combination undergo photochemical reactions in a manner not completely understood at present.)
9. That while the solution of the urban air pollution problem is long range, short-range steps should be taken to alleviate it further, as soon as reliable facts are available and policy decisions have been made.
10. That many of the findings of the Foundation, including methods of attacking the air pollution problem as well as remedies, are applicable to all metropolitan areas and should be widely disseminated.

## TECHNICAL REPORTS

*published by the*

### AIR POLLUTION FOUNDATION

- Report No. 1 "Meteorology of the Los Angeles Basin"  
M. Neiburger and J. C. Edinger, 99 pp., April, 1954.....\$ 3.00
- Report No. 2 "Combustion and Smog"  
W. L. Faith, 63 pp., September, 1954.....\$ 3.00\*
- Report No. 3 "Conference on Incineration, Rubbish Disposal, and Air Pollution"  
Francis R. Bowerman, Editor, 52 pp., January, 1955.....\$ 3.00
- Report No. 4 "First Technical Progress Report"  
W. L. Faith, L. B. Hitchcock, M. Neiburger, N. A. Renzetti,  
L. H. Rogers, 89 pp., March, 1955.....\$ 4.00
- Report No. 5 "Hydrocarbon Losses from the Petroleum Industry in Los Angeles County"  
Southwest Research Institute, 22 pp., November, 1954.....\$ 1.50
- Report No. 6 "Basic Statistics of the Los Angeles Area"  
Neil Goedhard, 74 pp., January, 1955.....\$ 3.50
- Report No. 7 "Tracer Tests of Trajectories Computed from Observed Winds"  
M. Neiburger, 59 pp., April, 1955.....\$ 3.00
- Report No. 8 "Field Evaluation of Houdry Catalytic Exhaust Converters"  
Southwest Research Institute, 77 pp., June, 1955.....\$ 3.00
- Report No. 9 "An Aerometric Survey of the Los Angeles Basin, August-November, 1954"  
N. A. Renzetti, Editor, 334 pp., July, 1955.....\$10.00
- Report No. 10 "Feasibility of Control Methods for Automobile Exhaust"  
Southwest Research Institute, 63 pp., August, 1955.....\$ 2.50
- Report No. 11 "Visibility Trend in Los Angeles"  
M. Neiburger, 45 pp., September, 1955.....\$ 1.50
- Report No. 12 "Second Technical Progress Report"  
W. L. Faith, L. B. Hitchcock, M. Neiburger, N. A. Renzetti,  
L. H. Rogers, 143 pp., November, 1955.....\$ 3.00
- Report No. 13 "Wind Trajectory Studies of the Movement of Pollutants in the Los Angeles Basin"  
M. Neiburger, N. A. Renzetti, R. Tice.....in preparation
- Report No. 14 "Photochemical Processes in Polluted Air"  
P. A. Leighton and W. A. Perkins.....in preparation

\*Out of print. Essential information of Report No. 2 now brought up to date and included in Report No. 12.

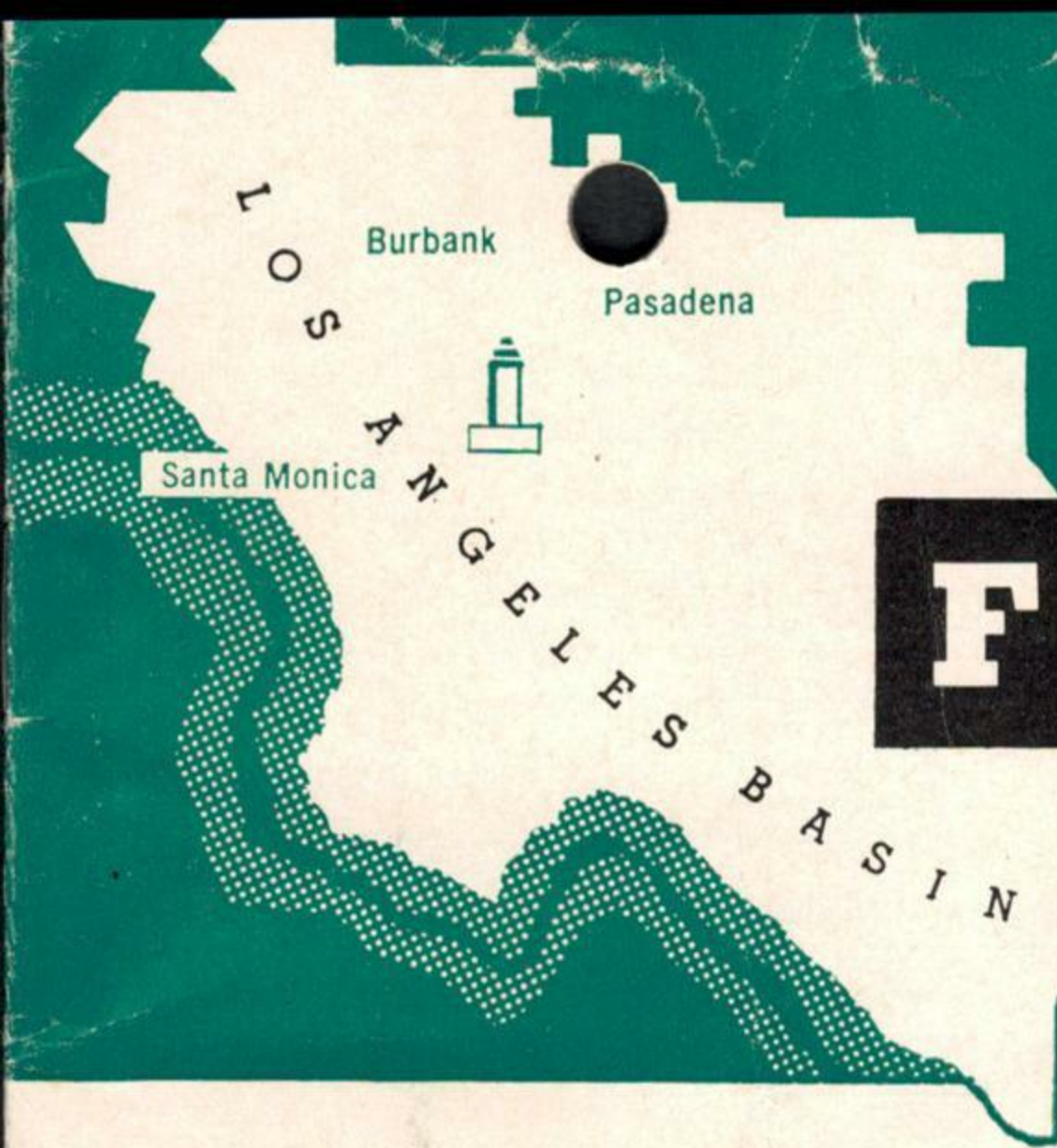
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Vernon Kilns  
Voit, W. J., Rubber Corporation  
Weber Aircraft Corporation  
Western Oil and Gas Association  
X-Ray Products Corporation

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The Board of Trustees at its Annual Meeting requested that copies of this report be sent to all friends and supporters of the Foundation. Additional copies are available free upon request.

*B. Vonnegut*



# Air Pollution

# FOUNDATION

704 SOUTH SPRING STREET  
LOS ANGELES 14, CALIFORNIA

# President's Report

Delivered to the Trustees and Supporters of the Foundation  
at the First Annual Meeting of the Board of Trustees  
at the Hotel Ambassador, November 16, 1954, by

**Dr. Lauren B. Hitchcock, President and Managing Director**

This meeting marks a milestone. One year ago, almost to the day, most of you met in this hotel and organized the Air Pollution Foundation. On November 16, 1953, the Foundation was officially incorporated under the laws of California as a non-profit research organization. I reported for duty on February 1 and started immediately to find permanent quarters for the Foundation and to select four top-notch scientists to work with me as a scientific team. In this we had the invaluable help of our Trustees. On March 15 we were at work at 704 South Spring Street and by the end of May we had largely completed our small but high-quality organization.

## Progress on Stated Objectives...

In its original Statement of Policy, issued in November, 1953, the Board of Trustees listed its seven intentions, aimed at expediting the solution of the smog problem.

**No. 1** Number one was "to assemble a competent technical staff to organize and direct a broad program of cooperation, research and public information."

I would now like to present to you the key men on our staff:



DR. W. L. FAITH  
Deputy Director and  
Chief Engineer



DR. M. NEIBURGER  
Senior Meteorologist



DR. N. A. RENZETTI  
Senior Physicist



DR. L. H. ROGERS  
Senior Chemist



BURT LEIPER  
Public Information Officer



ROBERT S. WEATHERLY  
Business Manager

Their competent and able work is our single most valuable resource. Assisting them we have the minimum possible office force, but one which makes up for its lack in numbers in earnestness, hard work and ability. This organization is fired with enthusiasm for its job and I will match their working hours and productivity against any organization represented here today. We even solved the coffee-break problem by buying our own percolator. Morale in this organization is one hundred percent.

Early this year we began to seek the cooperation and counsel of others in this area and nation-wide, who were in a position to help us. They have always responded wholeheartedly. Among these sources of voluntary assistance are the National Bureau of Standards, the Bureau of Mines, faculties of Universities here and elsewhere, as well as various scientific societies. They have helped and stand ready to assist us when we will need more help and know how to use it.

Without waiting for completion of our scientific team, we got underway immediately in evaluating work of others and in beginning to formulate our research plans.

We are fully aware of the need for an accurate, impartial and objective program of public information. We have deliberately refrained from announcing any conclusions during these past months, although we have been under much pressure to do so by certain segments of the public, because we have needed time to determine the facts. With the excellent cooperation of the press, radio and TV, we have reported to the public our activities and adoption of research programs. We believe we are now close to the time when we can help in a sound public information program. We are pledged to report to you and to the public and to the government our findings promptly.

## No. 2 . . .

The second purpose of this Foundation is "to determine, record and publish what has been accomplished to date by all agencies dealing with the Southern California problem." We have evaluated and summarized most, if not all, of the available data bearing on our entire air pollution problem. This will be published as rapidly as possible. In June, we published our first scientific report, summarizing



DR. LAUREN B. HITCHCOCK



available data on the *Meteorology of the Los Angeles Basin* by Neiburger and Edinger. 250 copies of this report were distributed to contributors, interested scientists over the country, and libraries, and the edition is now exhausted. We assembled conferences of experts on hydrocarbon chemistry, on ozone formation, on meteorology, resulting in summaries which are guiding us in our research plans. There is no quicker way to get up-to-date on these various scientific subjects than to have the experts tell you first-hand. Published literature often lags by two or three years and would take many months for us to read individually.

Our second technical report deals with a complete analysis of all available information bearing on combustion products and air pollution.\*

Much has been published from many sources dealing with our problem. A good deal of it leads to a consistent picture but unfortunately there is some fundamental and serious disagreement. We have research projects actively underway to resolve these differences, and we are making progress in summarizing and publishing our findings.

\*Published December, 1954, and distributed to contributors and libraries.

**No. 3** The third stated purpose of the Foundation is "to determine what remains to be done and to employ experts—through the device of research or service contracts—who will provide information and advice for the shaping of future policies and action." Much additional information is needed. I refer you to the condensed outlines of our research program attached hereto, which I shall discuss shortly.

Six different programs total over 30 active projects which, by the end of December, will have cost the Foundation about one half million dollars.

These projects have been placed at Stanford Research Institute; Midwest Research Institute at Kansas City, Missouri; Southwest Research Institute at San Antonio, Texas; Armour Research Foundation, Chicago, Illinois; University of California; Arthur D. Little, Inc., Cambridge, Mass.; Battelle Memorial Institute, Columbus, Ohio, and others. Local laboratories, such as those of Truesdail and of Chaney, are carrying out substantial assignments. Faculty personnel from Cal-Tech, USC, UCLA, and Stanford University are working for us. As I am sure you know, we have no laboratories of our own, but place all our work at existing competent laboratories.

This entire program is aimed at providing facts on which we can base recommendations for remedial action. We must find the answers to such questions as, "What is smog?" "What is the contribution of the automobile exhaust—of incinerators—of industry?" "What practical remedies are there?"

**No. 4** The fourth purpose of the Foundation is "to collect information as to what other municipal areas have done and are doing under similar circumstances." By personal visits to, or studies of, New York, Pittsburgh, St. Louis, Chicago, San Francisco, and Louisville, we have learned something of their individual approaches to their local problems. By and large they are still in the smoke phase—that is, dealing with particulate matter to a large extent from incineration and rubbish disposal, currently regarded by some of these other cities as their Number One problem. Invisible, gaseous smog, we believe, is the coming primary national problem, as it appears to be Los Angeles' already. Because of our environment here, we believe we have a much more advanced and more serious air pollution problem; as little as we know so far, we know much more about it than these other cities.

**No. 5** Our fifth objective is "to provide and maintain a library of materials pertinent to the subject of air pollution." This has been done. We are building up a carefully selected collection of pertinent literature with emphasis on current scientific papers, both local and world-wide. We rely on our libraries in the community for many standard references and books, but there is a much larger literature on air pollution than you might realize and it is growing rapidly. This is an indispensable resource in evaluating man's present knowledge and spotlighting needed research.

**No. 6** Our sixth purpose is "to consult with, exchange information with, and to suggest to governmental and private agencies those research activities, enforcement methods, or other matters which have not yet been conducted or tried, and which seem to offer promise of air pollution abatement, so that the efforts of all groups and individuals may be coordinated properly." This is going on almost continuously. We work closely with the Air Pollution Control District and with university and other research centers. We held a three-day conference with nationwide representatives of the automotive industry in August and we have a two-day conference with similar experts in the field of rubbish disposal and incineration scheduled here for December 2 and 3.\* Through such meetings we obtain a valuable exchange of information.

We have conferred frequently with the Board of Supervisors during the year, especially in connection with research projects now being undertaken by the Foundation for the County. We participated in conferences called by Governor Knight and Senator Kuchel late in October.

We were called on the other day by the Board of Supervisors to submit our recommendations for what we considered an essential research program. In presenting this program to them, totalling over 2 million dollars, we have perhaps one of the best examples of coordination with governmental agencies.

**No. 7** The seventh assigned duty is "to publish current information by the most appropriate means on all phases of air pollution and its abatement." I have already discussed this activity.

Naturally most of our coordination effort, as in other matters, lies ahead of us.

\*Proceedings of this very successful conference are in press and will appear soon.

## What We Are Finding Out...

Now I want to try to tell you some of the things we have found out so far, particularly as they help to define the problem, and show you how our current program leads into the larger program for 1955. Please remember that our current projects were only started this summer, and for the most part are still going ahead actively and increasing in number. All I can give you now is a progress report.

The first problem which confronted us was to decide what the outer limits of our Los Angeles atmosphere were—that is, just what is the land area and amount of air over it, which are critically affected. At the start we found that it was loosely described as the City of Los Angeles, or Los Angeles County, or a basin of 1100 or 1200 square miles in extent. Careful meteorological study indicates that the critical area is about 1630 square miles and the critical atmospheric volume one which exists under low temperature inversion layers ranging from surface inversions to perhaps 2000 feet. We chose as a typical height to the base of this inversion layer an altitude of 1200 feet. At this level we examined the surrounding mountains and established certain boundaries. The result is the area shown in this outline map. (See picture, page 3.) Actually, this is a scale model of the atmosphere of the Los Angeles Basin in which one inch equals a mile—held edgewise the thickness of this board presents the thickness of our air under the inversion lid. This helps to visualize the extremely thin sandwich of air between ground layer and inversion layer in which we live, and helps to understand why we have so much relatively stagnant air and poor ventilation.

## Activities in Our "Air Chamber"...

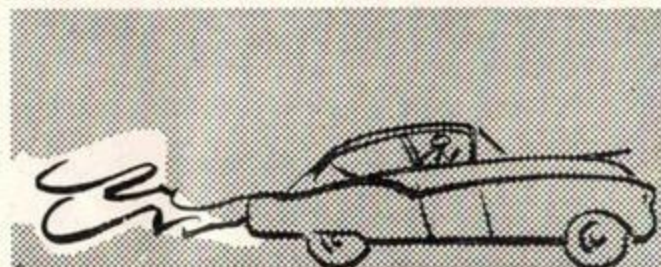
In studies recently completed for us by two members of the University of Southern California faculty, Ballard and Goedhard, the current population in this Basin is estimated at 5,030,000. Of the 1,630 square miles total in the Basin, 1145 are in Los Angeles County and 485 in Orange County, or exactly one-third of the total area in these two counties, in which reside about 98% of the total population of both counties.

Within this limited air chamber we have currently a total of 2,361,000 motor vehicles, according to our investigators Ballard and Goedhard, burning a total of 4,680,000 gallons of gasoline per day or 14,040 tons. There is no accurate information on the number of domestic incinerators nor of the amount of rubbish burned in them, but exhaustive research by them suggests as a rough guess about 1,500,000 such incinerators burning about 5000 tons per day.



## Imperfect Combustion...

Within this same area we have tremendous industrial activity. We have installed through-put capacity for refining about 39,000,000 tons of crude oil per year. We have capacity for steel production of  $2\frac{1}{4}$  million tons per year as the largest steel-producing area west of Chicago. We have the generation of power for industry and for our homes, for which we have a choice of two hydrocarbon fuels, natural gas and fuel oil. In our automobiles we have a third hydrocarbon fuel that is called gasoline. All told the 5,000,000 and their industry in this restricted air chamber burn over 50,000 tons of fuels and rubbish every 24 hours. This in itself would not be serious, but unfortunately all of these combustion processes are imperfect, some more so than others. Preliminary indications are that over 3000 tons per day of unburned fuel or partially burned fuel plus oxides of nitrogen and sulfur result from our combustion processes, excluding carbon dioxide, carbon monoxide, dust particles and soot. Carbon monoxide is probably in excess of 6000 tons per day.



These pollutants have many sources scattered over our Basin. They come from automobiles, incinerators and industry, with industry contributing about one-third. All available research work of others indicates that on the average 7% of gasoline supplied to motor vehicles comes out of the exhaust pipe unburned with additional quantities escaping from carburetors and crankcases. Based on the normal consumption of gasoline in the Los Angeles Basin, it is a matter of simple arithmetic to calculate that this source contributes about 1000 tons per day of hydrocarbons, plus organic acids and aldehydes, plus about 300 tons of oxides of nitrogen and sulfur. This is not a matter of opinion. The automotive industry recognizes the automobile as the largest single source of hydrocarbons in our atmosphere. Competent scientific evidence is mounting to show that automobile exhaust gases in the concentrations found in our atmosphere are capable of forming ozone and may be considered a definite source of smog.

Further confirmatory work appears to be needed before there is substantial agreement by all concerned on the cause-and-effect relationship between these various pollutants and the formation of smog. This research is one important part of our program.



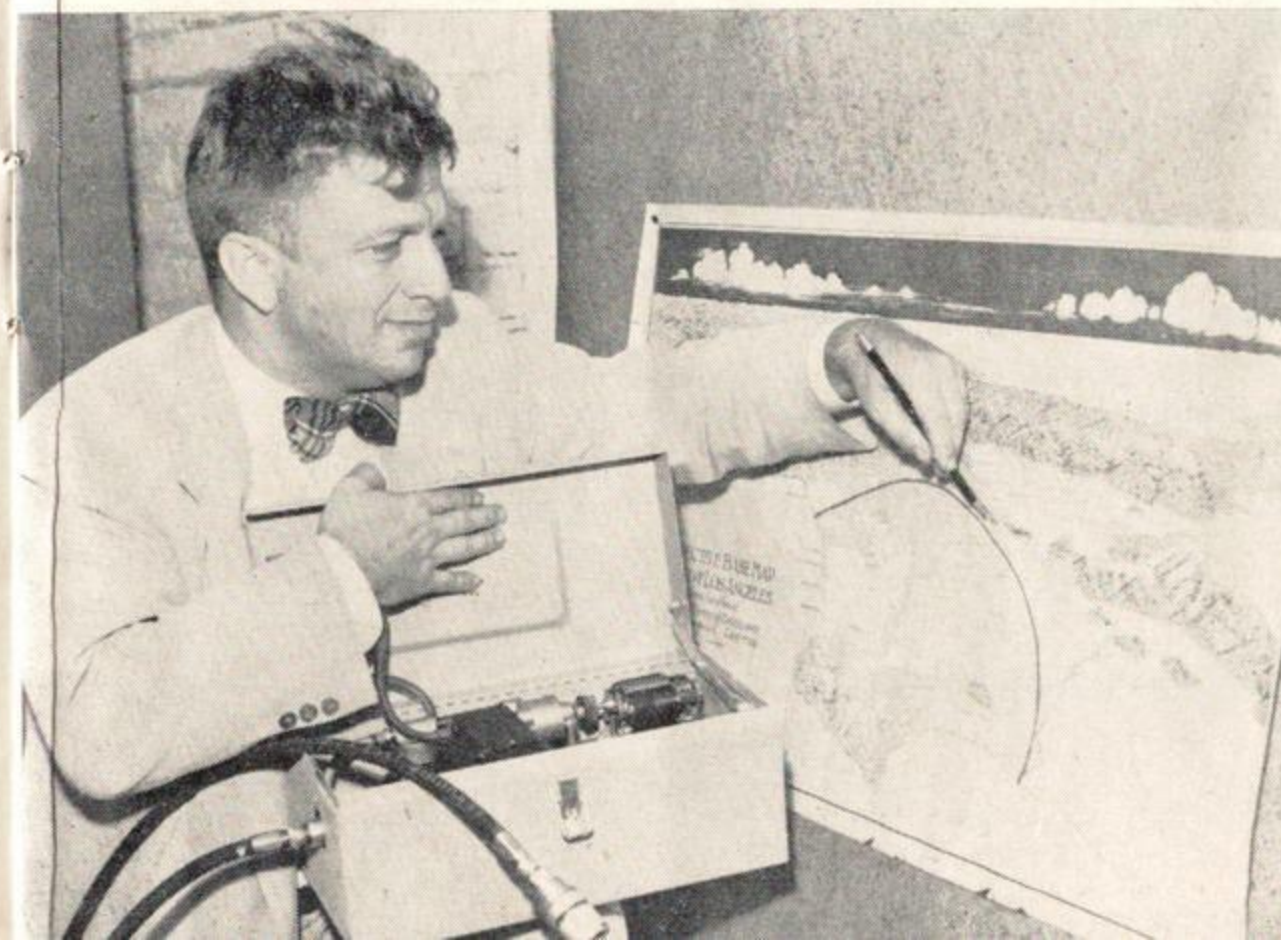
## Aerometric Survey...

Now, I would like to tell you briefly about a few of the most important projects on our research program. As you will see from the accompanying Tables (next page), the biggest single program this year and next is the Aerometric Survey. This is an intensive analysis of our atmospheric environment, including analyses of the air for contaminants at various locations and a correlation of air composition with known manifestations of smog, i.e., eye irritation, plant damage, reduced visibility and high oxidant content. In addition to ten stations in the Basin are one in Santa Barbara for control purposes, and one in Riverside, about 50 miles inland. The current survey of four months began in August. We are measuring up to ten variables, but due to limitations of money and manpower, have not been able to do all measurements at all stations this year.

We are also sampling the air at various heights above some of the stations. With the cooperation of the U. S. Navy, we have done sampling from a Navy blimp.

## Air Tracer Survey...

In order to follow the movement of polluted air masses, it is of course essential to have complete meteorological data. Accordingly, through the cooperation of the District, we have records from 52 wind stations throughout the Basin. In order to verify our method of calculating wind trajectories, we have been carrying on a program of air tracer tests in which fluorescent particles are released in one corner of the Basin and the movement of air charted by collecting and counting these particles on a system of filters, located on a 25-mile arc with a radius of about 13 miles. Six air tracer runs have been made this summer. Present indications are that the accuracy of calculated wind trajectories can be improved by having more wind observations aloft.



**DR. N. A. RENZETTI,**  
Foundation Physicist,  
demonstrating sampler  
equipment, points to  
the 25-mile arc set up  
for Air Tracer Survey  
to verify calculation  
of wind trajectories.

## Refinery Emissions...

You will note that we have now discussed or explained briefly all of the projects in Table II except the refinery emissions audit. This has just been completed and I am glad to be able to make this first report to you today. It became obvious to us some months ago that one of the most controversial and possibly significant sources of pollution in this Basin was the emissions of hydrocarbons from refineries. We made up our minds that an absolutely independent audit should be made. A nationwide search by the Foundation resulted in the choice of the Southwest Research Institute of San Antonio, Texas, as a competent and impartial auditor. Under the direction of Dr. Judson Swearingen, a recognized authority, but who has

TABLE I  
*Research Programs (Summary)*

|                      | 1954<br>(6 mos.) | 1955        |
|----------------------|------------------|-------------|
| Meteorology          | \$ 46,800        | \$ 62,000   |
| Chemical Research    | 71,400           | 252,500     |
| Combustion Products  | 32,800           | 422,850     |
| Aerometric Survey    | 253,000          | 616,550     |
| Sources of Pollution | 10,500           | 50,000      |
| Physical Research    | 2,000            | 185,000     |
| Total                | \$416,500        | \$1,589,400 |

TABLE II  
*Projects Completed in 1954*

|                                   |           |
|-----------------------------------|-----------|
| Meteorology Report                | \$ 3,000  |
| Air Tracer Survey                 | 36,760    |
| <i>Conferences:</i>               |           |
| Meteorology                       | 890       |
| Hydrocarbons, Ozone, Mass Spec.   | 2,000     |
| Vehicle Combustion Products       | 2,800     |
| Refuse Disposal and Air Pollution | 3,000     |
| Aerometric Survey                 | 225,000   |
| Refinery Emissions (Audit)        | 8,000     |
| Total                             | \$281,450 |

never been in the employ of any petroleum company, a personal and physical check of all hydrocarbon losses was made in all of the major refineries in this Basin and in typical, small, independent refineries. Hundreds of samples were collected by Southwest Research Institute and analyzed under their supervision. Capacities of storage tanks and characteristics of other equipment were determined independently by them. We believe our survey has been more thorough than those made by the petroleum refineries themselves. The findings of the Southwest Research Institute may be summarized as follows:

The total hydrocarbon emission to the atmosphere in the Los Angeles Basin is estimated at 251 tons per day. The difference between this figure and the 224 tons per day reported by the Western Oil and Gas Association in March, 1954, is believed to be within the range of error to be expected in these types of estimates. The olefin losses of amylenes and heavier are placed at 16.4 tons per day compared to 12.2 tons per day reported by the Association. This audited value for olefins was based on the best available average annual composition of motor gasoline produced and marketed in Los Angeles County as of August, 1954, an analysis which was not available in comparable form in March of this year.

The audit covered nine major and eleven independent oil companies in Los Angeles County and included personal inspection of oil fields producing 52% of the County's annual oil production, refineries possessing 95% of the County's refining capacity, and all bulk and marine terminals. Examination of plant records, interviews with technical personnel, inspection of facilities, and collection and analysis of samples were performed and the calculated results are believed as accurate as can be obtained without very extensive and elaborate studies.

TABLE III  
*Projects Started in 1954, Continuing in 1955*

|                                     |           |           |
|-------------------------------------|-----------|-----------|
| Inversion Modification              | \$ 6,000  | \$ 4,000  |
| Smog-Forming Reactions              | 60,000    | 126,000   |
| Infrared Absorption, Long Path      | 2,000     | 3,000     |
| Photochemical Reactions             | 7,500     | 30,000    |
| Composition of Auto Exhaust         | 26,000    | 37,850    |
| Composition of Incinerator Gases    | 2,000     | 25,000    |
| Interpretation of Aerometric Survey | 30,000    | 25,000    |
| Sources of Pollutants               | 4,000     | 50,000    |
| Spectral Radiometry                 | 7,000     | 20,000    |
| Total                               | \$144,500 | \$320,850 |

## Identification of Smog Formers...

In Table III you will note a project entitled briefly "Smog-Forming Reactions" which will probably total \$60,000 by the end of December and for which we propose \$126,000 for next year. In this project, smoggy air is being tested by various means to measure its effects, then one pollutant after another is removed successively, and after each removal the smog effects are measured again. It appears possible in this way to eliminate many pollutants so far as effects of eye irritation, plant damage, or ozone formation are concerned. We believe that ozone formation and eye irritation occur entirely in the daytime, yet it is possible at times to take polluted air at night, irradiate it with artificial sunlight and produce smog. Elimination of pollutants is proceeding and we hope eventually to be able to identify the substance or substances directly responsible. This should do much to enable us to diagnose and prescribe remedies. Naturally, it is most exacting and painstaking work and requires highly trained scientists and expensive equipment.

Further down the list you will notice "Photochemical Reactions." Here is another example of the independent confirmation which we believe is needed to demonstrate conclusively ozone formation from auto exhaust, as well as from hydrocarbons. Composition of auto exhaust needs more study and especially incinerator gases. The auto exhaust project is underway at Midwest Research Institute and the project on incinerator gases has recently been placed at the Battelle Memorial Institute.

## "Pilot Plant" Studies of the Basin Atmosphere...

Table IV sets forth a large part of our program for 1955. Leading the list is a study of the smog-forming potentials of various pollution sources, especially combustion products. One would like to experiment with the entire Los Angeles Basin but this is impracticable, as we can't control the weather. In a large chamber of special construction we could supply auto exhaust at one time, backyard incinerator smoke at another, hydrocarbons at another, and then a mixture of two or more of these pollutants. We could control the temperature, humidity, concentration of pollutants, the amount of light, etc. We could find accurate answers to such questions as, "Does auto exhaust actually form smog?" or, "What would be the effect of closing down the refineries, or stopping all incinerators, or keeping all cars off the road?" Two years with this operation, whatever the cost, would be time and money saved in trying futile experiments on the whole Basin itself. This program seems to us to be appropriate for the University of California with perhaps the main installation at Riverside and the help of experts on the faculties at other campuses. These findings would increase our understanding of air pollution not only in the Los Angeles Basin, but in the Bay area, in San Diego, and other cities.

## Need for Better Tools...

A group of the projects you will see have to do with the development of various methods and instruments for measurement. So far in all air pollution work, we have been working with tools comparable to the axe and sledge hammer of pioneer days. We have selected carefully a list of the greatest needs for scientific tools. They compare to the handsaws, turret lathes, precision machine tools, and other modern tools essential to building in this modern world. We, too, are trying to build something very important and are seriously handicapped. Scientists everywhere are aware of this vital need. This sort of work could be done in the laboratories of various universities in California.

TABLE IV  
*Projects Proposed to Start in 1955*

|  |             |
|--|-------------|
| Combustion Products (UC-Riverside)   | \$ 250,000  |
| Carbon Isotopes  | 15,000      |
| Review and Summary—Photochemical Reactions   | 7,000       |
| Air Tracer Survey  | 30,000      |
| Trend in Visibility  | 2,000       |
| Development of Machine Methods for Computing Wind Trajectories                         | 25,000      |
| Nature of Reactants with Neutral Buffered Potassium Iodide and Phenolphthalin          | 10,000      |
| Mass Spectrometer Studies  | 50,000      |
| Development of an Automatic Nitrogen Dioxide Instrument                                | 2,500       |
| Development of Infrared Techniques   | 10,000      |
| Application of Non-Dispersive Infrared Analyzer for Hydrocarbons                       | 10,000      |
| Application of Non-Dispersive Infrared Analyzer for CO                                 | 5,000       |
| Feasibility Study for Automatic Continuous Measurement of Olefins, Acids and Aldehydes | 2,000       |
| Oxidation of Exhaust Gases   | 60,000      |
| Evaluation of Exhaust Control Devices  | 50,000      |
| Aerometric Survey, Winter-Spring 1954-1955   | 25,000      |
| Aerometric Survey, Summer-Fall 1955  | 566,550     |
| Use of Microwave Spectra for Identification of Smog Constituents                       | 33,000      |
| Continuous Measurement of Atmospheric Ozone by Spectrographic Method                   | 20,000      |
| Paramagnetic Resonance Studies   | 2,500       |
| If successful, additional for research phase   | 25,000      |
| Nuclear Magnetic Resonance   | 35,000      |
| Area Distribution of Sources of Air Pollutants   | 50,000      |
| Measurement, Composition and Mechanism of Formation of Aerosols                        | 30,000      |
| Absorption Spectra of Gaseous Atmospheric Pollutants                                   | 25,000      |
| Total  | \$1,340,550 |

## Controlling Auto Exhaust...

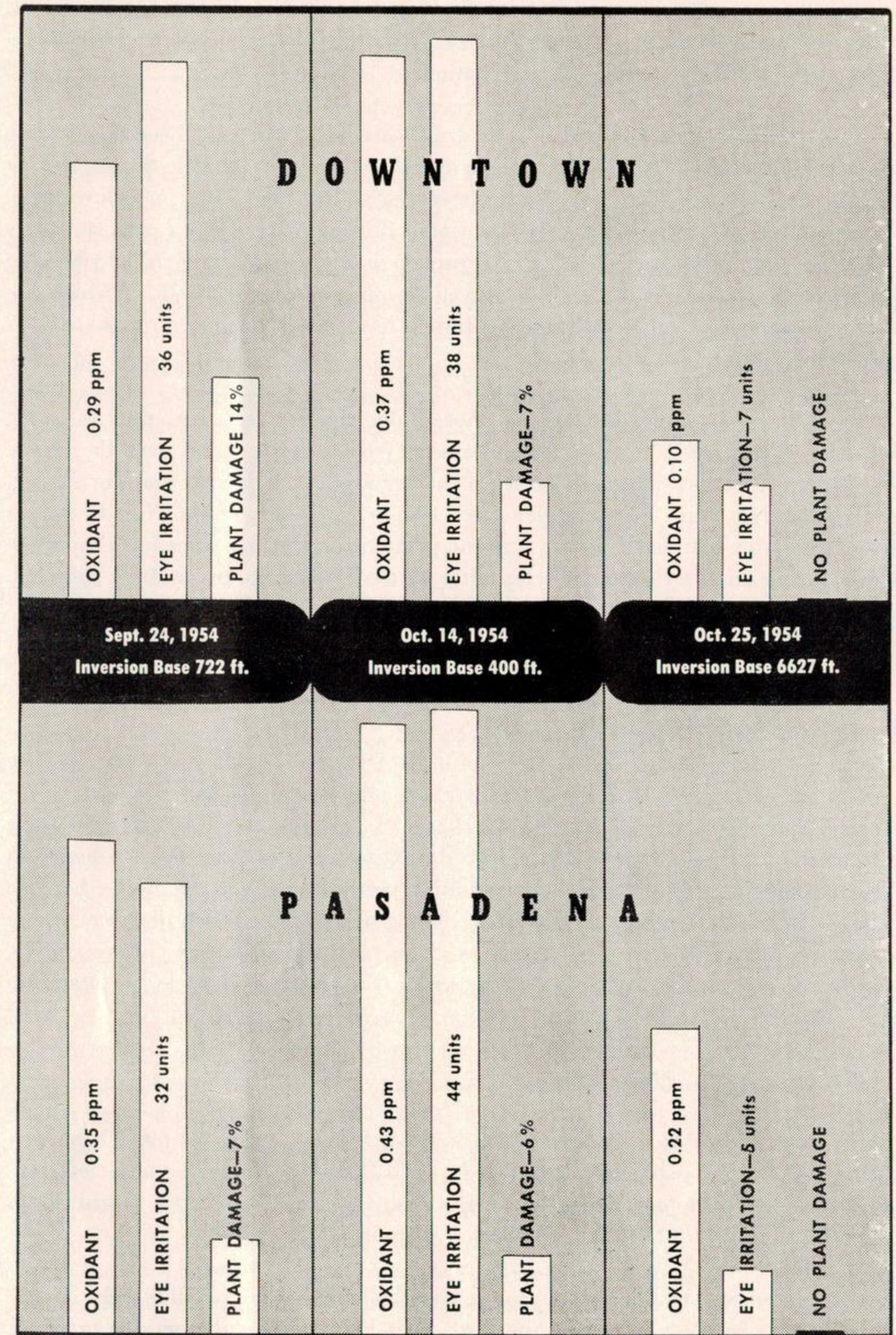
Midway down the list (Table IV) are two projects directed at the development of auto exhaust control methods. First, we feel that the oxidation process requires testing of various catalysts for efficiency, operating life under prolonged operation, maximum temperatures, and accordingly the metals and types of construction indicated. All these basic things are still unknown. At the same time a number of devices have already been proposed by some pioneers and even though designed and built without the benefit of fundamental data, it is possible some of these devices could help in the meantime. A setup is needed to thoroughly test them under all road and traffic conditions.

We feel the Aerometric Survey should be continued on a reduced monitoring basis through the winter and spring months and then start next July on an expanded basis. We must learn more about our atmospheric environment.

Naturally, there is a great deal of interest in what will result from our Aerometric Survey from 1954 and still going on. We will have over 100,000 measurements by the end of this month and the scientific evaluation of these results will take several months. The Air Pollution Control District is supporting this Aerometric Survey financially and making available to us the data from their measurements made at the same time in the Basin this summer. We will put all of this together in our final report which will be submitted to the District. I know you would like to know right now what we have been finding and the best I can do is to let you see a few samples. We selected what seemed to be the two worst days this summer, namely September 24 and October 14 to show you how certain pollutants ran up with eye irritation when the inversion layer was low. Please bear in mind that because of the time we are showing only a few pollutants at two stations. To show you the data for all ten stations throughout the summer would take at least one full day. Furthermore, until we get all the data together, we cannot draw any conclusions.

The upper portion of the accompanying chart compares certain measurements made at our downtown station on the fourth floor of a building on the corner of Sixth and Spring Streets. High values for oxidant, eye irritation and plant damage are noted for both September 24 and October 14. The plant damage was somewhat less. It is possible that plants are damaged by different substances than those causing eye irritation. Note the very low height of the inversion layer on both dates. For comparison a pleasant day is shown at the right on October 25, when the inversion height was over 6000 feet, eye irritation and plant damage are practically absent, but interestingly enough, oxidant value is still measurable, but below normal eye irritation levels.

In the lower portion, similar measurements are reported for the same dates at the Pasadena station. Here will be noted that substantially the same high values were



measured for oxidant, eye irritation and plant damage, but on October 25, which was rated as a pleasant day downtown, oxidant value was more than twice the downtown value and there was some eye irritation.

Altogether over one hundred thousand measurements will have been made when we bring this study to an end for the current season on December 1. So far, during the survey, hydrocarbons have varied from nearly zero up to 1.6 ppm downtown, and up to 0.4 ppm in Pasadena. Carbon monoxide seems to reach a peak normally about 8:00 a.m. downtown, and it has reached as high as 30 ppm. Aldehydes (an oxidation product of hydrocarbon) as well as nitrogen dioxide, both of which are also products of most combustion processes, have reached concentrations of 0.7 ppm downtown.

Again this survey is establishing more fully the extreme variation in smog intensity as measured by these various means from point to point over the Basin. For example, we have obtained severe plant damage at our Rivera and our Bassett stations on days when the plant damage downtown was very slight. Nor do we yet see a correlation between oxidant value and plant damage, which some have expected, although this could of course develop after all the data has been carefully digested.

## Large Program for 1955...

This is the biggest 12 months' research program ever drawn up for the Los Angeles air pollution problem. On the basis of presently known facts and their relationship to the unknown, it could be three times as big. It is a large figure in comparison to the rate at which air pollution research has been going on here so far. We believe the state of our knowledge is just beginning to reach the point where we can realistically assess the magnitude of our problem. It is our sincere conviction that the seriousness and the emergency of this problem deserves an attack on this scale.

We believe the listed projects are all-important.

Our total research program for 1955 is estimated at close to \$1,600,000, which with our operating expenses adds up to over \$1,800,000. With the studies of stop-gap procedures recommended by us to the Board of Supervisors this morning, an over-all program of \$2,214,000 has been presented.

It is, of course, obvious that a program of this size will be possible only if supported largely by the County and the State. This Foundation will continue to do all

it possibly can with funds it can derive from private sources and it is expected that the Foundation will seek \$750,000 from its own supporters. We assume that Los Angeles County and the State of California, with the Foundation, will find ways and means of carrying out this very necessary program.

Management is always confronted in any pioneering development with the tough question, "How much research?" If you do too little in the hope of saving time and money, you get no answer or the wrong answer. If you do too much, you can go broke. We face the same problem. After taking into account all the work that has been done to date, we find large areas of ignorance and no quick or significant remedies. We can readily give you a six million dollar program, all of which looks interesting; but we have selected what seemed to us the essential projects, those which are most likely to produce useful answers. We have done our best to strike a balance between expediency and the purely academic, between too little and too much.

## Summary of Our Present View...

To summarize, we got organized in the first four months and underway with a research program in the second four months. While not yet in a position to announce conclusions, we have evaluated available information to the point where we feel we are beginning to see the over-all problem in good perspective; for instance, that our air pollution has two primary aspects, gross pollution by many substances, and under certain conditions transient eye-irritants, plant-damaging compounds, etc. The two may or may not be closely connected. The reduction of one may not necessarily reduce the other. Together they constitute what is popularly called smog but most commonly identified by eye irritation, reduced visibility, and odor. Gross air pollution may not be physiologically harmful, but we assume it is. Further, it is beginning to look to us as if the contribution of pollution from industry, substantial as it is, is about half the contribution by the public through its automobiles and incinerators; that further identification and diagnosis of these still very qualitative estimates is essential; that the solution will require development of practical, workable remedies, because we cannot prohibit essential activities until there are workable and acceptable alternatives; that there is every reason to believe these remedies can be developed; that it is going to take concentrated effort of industry, government and private agencies on a scale more comparable to wartime effort than the typical peacetime civic welfare movements, and that this Foundation, unique in the air pollution field, is in an excellent position to catalyze this effort, contributing only so much of its own research as will stimulate and guide those who have the basic responsibility and the large resources.

## Can Smog Get Worse?...

In closing, let your minds return to this image of the Los Angeles Basin and its restricted air chamber. Today its 1600 square miles, already teeming with over 5 million inhabitants, hundreds of industries, 2,361,000 motor vehicles, perhaps one and one-half million incinerators, burning improperly over 50,000 tons per day of various materials, has a certain pollution level which at times reacts to eye-irritating smog of an intensity with which you are familiar regardless of how we measure it or define it scientifically. Look ahead two years—four years—or even six years—in 1960 the Ballard-Goedhard reports, which are now being prepared for publication, estimate that we will have a Basin population of 6,200,000 people, nearly three million motor vehicles burning 18,000 tons of gasoline a day. 1,860,000 incinerators burning 6200 tons of rubbish per day—but why go on? Despite the fine work of the Air Pollution Control District in eliminating over 900 tons per day of pollutants so far, the astonishing growth of this Basin may swell our pollution faster than we can reduce it and hence smog may get worse. How much worse does it have to get? How intolerable does our atmosphere have to get before enough people say “this is the limit—I’ve had enough!” Is this community going to wait until that time comes (if it has not come already) to stop wrangling and criticizing each other and unite behind a well-organized, large-scale attack on this problem?

## Cure or Kill?...

We of the Foundation staff say to you that the research program we have submitted is irreducible, that anything less is temporizing, that this community necessity is above politics or any private interest, that if we start an all-out effort now, we may hope to have tolerable air in five years and relief perhaps sooner. We must lose no time; we cannot in a battle “research” out the last percent of uncertainty; but we must know what we are doing, for we can kill the patient by one too many “untested cures.” Industry is our livelihood—whether you and I work in a factory or supply industry with services like insurance, food, clothing, entertainment or shelter. Our industry is our productivity; our problem is to find out how to restore tolerable air and *improve* our productivity.

## Cost of Other Necessities...

From time immemorial, one thing man has always had plenty of the world over is air. “Free as air” has been a household word. In the Los Angeles Basin for natural reasons, so far as we know completely beyond man’s control, our air supply

is limited—at times severely. Air is no longer free here and there is not enough of it. Consider a moment our other indispensable human necessities here: water, one of our most valued resources which we almost take for granted, represents an investment for the Los Angeles Basin of somewhere around \$750,000,000. There is no great clamor over whether or not we should have potable water, and we shall probably have to have more of it. Take sanitary sewage disposal. Would we contemplate for a moment going back to the days of medieval London where refuse of all sorts was thrown in the streets? In the Los Angeles Basin we have invested perhaps 250 to 300 million dollars in our sewage system. Our highway system in Los Angeles Basin represents an investment of several billion dollars. Our harbor cost us 97 million dollars. How much is tolerable air worth to you people in this Los Angeles Basin? We don’t know what the cost will be yet, but we strongly suspect it will be more like some of these other indispensable services which you already enjoy. We recommend the attack for the next 12 months on the 2 million dollar scale. This is one cent a week for every person in the Los Angeles Basin. How badly do you want tolerable air?

We in the Foundation are here because we believe this job can be done. But a five-man scientific team, even if they were all Nobel prize winners, cannot do it alone. The Air Pollution Control District cannot do it alone. Government cannot do it alone. Citizens’ Committees cannot do it alone. It requires a concerted, all-out, united effort. The problem is still with you because only now has its magnitude even been faintly understood, because many hoped for short cuts, because there are still faint hearts in the community, and all this spells failure. We ask your help—we ask for your united support—and we tell you this problem *can* be licked. You have our recommendations. The solution IS possible—but not on a part-time basis!

We in the Foundation feel still greater enthusiasm and hope than when we started. We are tackling in a pioneering phase one of the biggest social problems man has yet encountered—one which requires all the scientific knowledge and technology man has, plus new knowledge. The work of this Foundation and of all of you in this community is already being watched by the nation and other countries as a most hopeful approach to the threatening general problem. We believe tolerable air has a value like potable water, like sanitary sewage disposal, like the harbor—that your investment in our program will pay equally valuable dividends.



## Contributors

American Airlines  
American Motors Corporation  
American Potash & Chemical Corp.  
Associated Brick Mfgs. of So. Calif.  
Atchison, Topeka & Santa Fe Railway  
Bank of America  
Barker Bros. Corporation  
Bechtel Corporation  
Bendix Aviation Corporation  
Bethlehem-Pacific Coast Steel Corp.  
Beverly Hills Hotel  
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Bullocks, Inc.  
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Checker Cab Manufacturers Corp.  
Chrysler Corporation  
Citizens Nat'l Trust & Savings Bank of L. A.  
Coldwell, Banker & Company  
Cooper Precision Products  
Desmonds, Inc.  
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Los Angeles Herald & Express  
Los Angeles Mirror  
Los Angeles Times  
Los Angeles Turf Club  
Mack Trucks, Inc.  
May Company  
National Trust & Savings Association  
North American Aviation, Inc.  
Northrop Aircraft, Inc.  
Pacific Clay Products  
Pacific Mutual Life Insurance Company  
Pacific Telephone & Telegraph Company  
Peterbilt Motors Company  
Prudential Insurance Co. of America  
Radioplane Company  
Reo Motors Inc.  
Riverside Steel Construction  
Robinson, J. W., Company  
Rowan, R. A., & Company  
Schlitz, Jos., Brewery Company  
Sears, Roebuck & Company  
Security-First National Bank of L. A.  
Southern California Edison Company  
Southern California Gas Company  
Southern Counties Gas Company  
Southern Pacific Company  
Southern Pipe & Casing Company  
Stauffer Chemical Company  
Studebaker-Packard Company  
Tayler-Spotswood of California  
Transco Products, Inc.  
Twin Coach Company  
Union Bank & Trust Company of L. A.  
United Air Lines  
United States Steel  
Walter Motor Truck Company  
Western Oil and Gas Association  
White Motor Company

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The Board of Trustees at its Annual Meeting requested that copies of this report be sent to all friends and supporters of the Foundation. Additional copies are available free upon request.

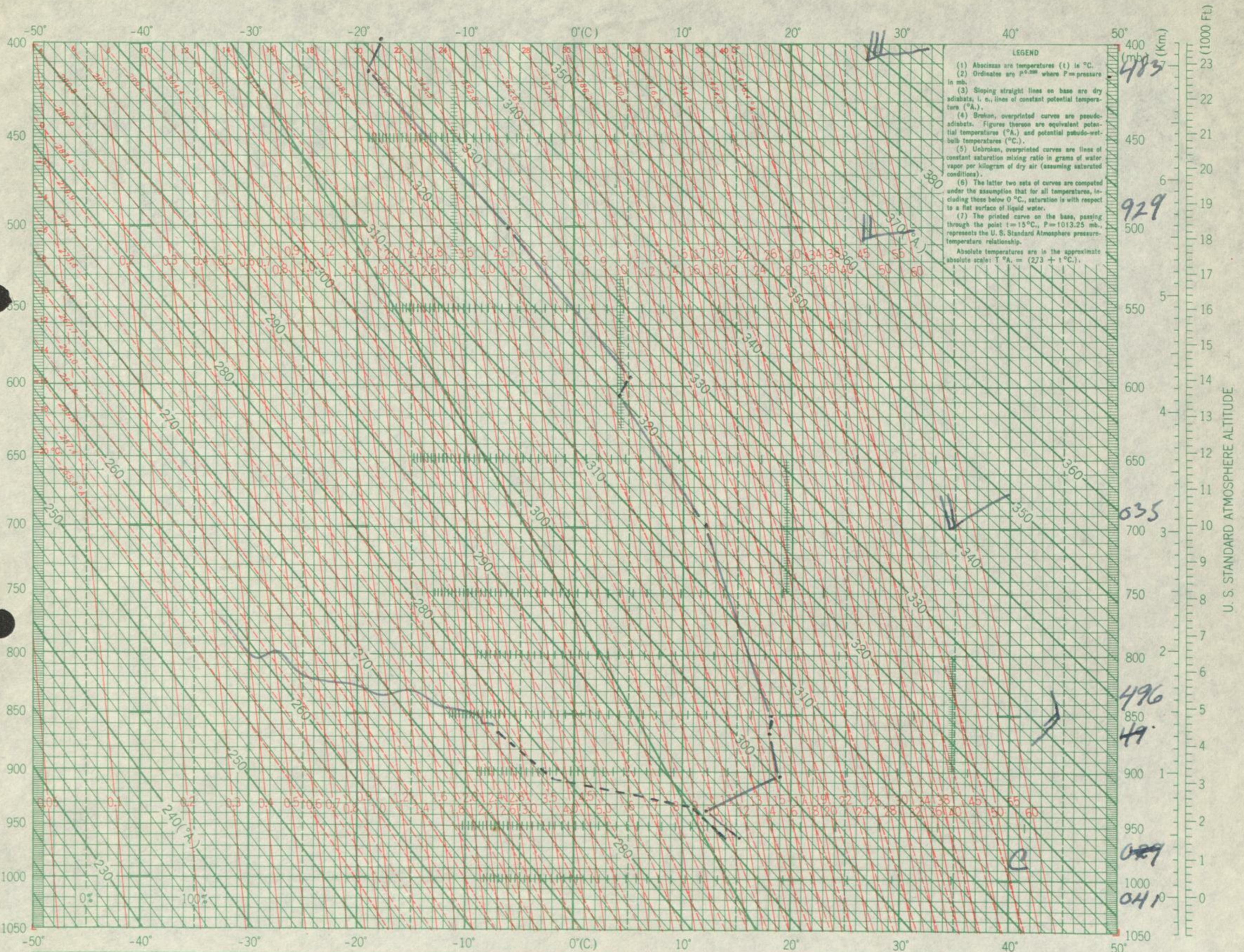
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## Governor Goodwin J. Knight on Smog:

*"I am convinced we will be successful so long as we recognize that it is a problem to be solved by engineering and scientific endeavors and not by political sound and fury."*

PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

- (1) Abscissas are temperatures (t) in °C.
- (2) Ordinates are  $p^{0.2857}$  where P = pressure in mb.
- (3) Sloping straight lines on base are dry adiabats, i. e., lines of constant potential temperature (°A).
- (4) Broken, overprinted curves are pseudo-adiabats. Figures thereon are equivalent potential temperatures (°A) and potential pseudo-wet-bulb temperatures (°C).
- (5) Unbroken, overprinted curves are lines of constant saturation mixing ratio in grams of water vapor per kilogram of dry air (assuming saturated conditions).
- (6) The latter two sets of curves are computed under the assumption that for all temperatures, including those below 0 °C, saturation is with respect to a flat surface of liquid water.
- (7) The printed curve on the base, passing through the point  $t = 15^\circ\text{C}$ ,  $P = 1013.25$  mb., represents the U. S. Standard Atmosphere pressure-temperature relationship.

Absolute temperatures are in the approximate absolute scale:  $T^{\circ\text{A}} = (273 + t^{\circ\text{C}})$ .

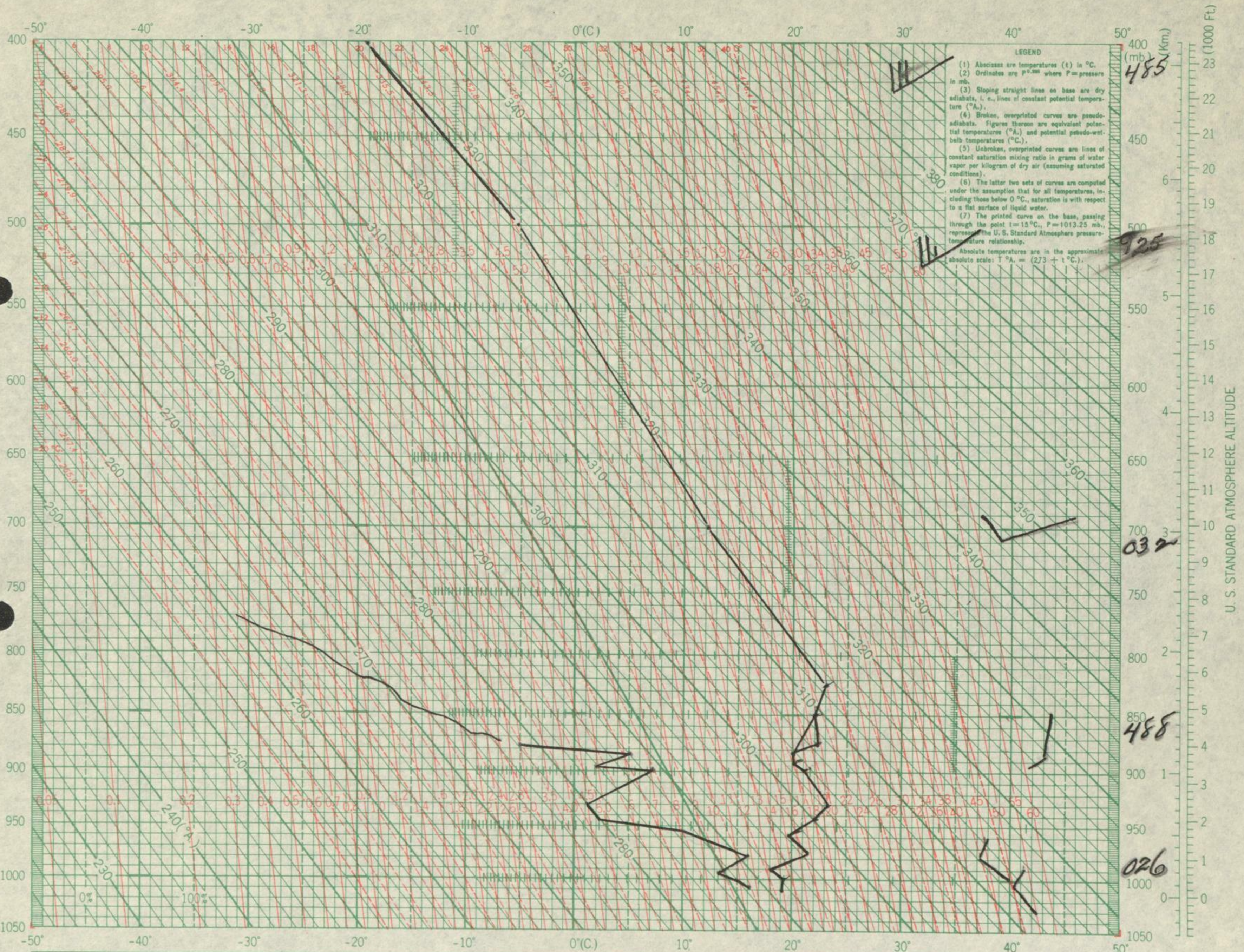
U. S. STANDARD ATMOSPHERE ALTITUDE

Station RIV Date (G.C.T.) 19 AUG '54 Hour (G.C.T.) 0700



# PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

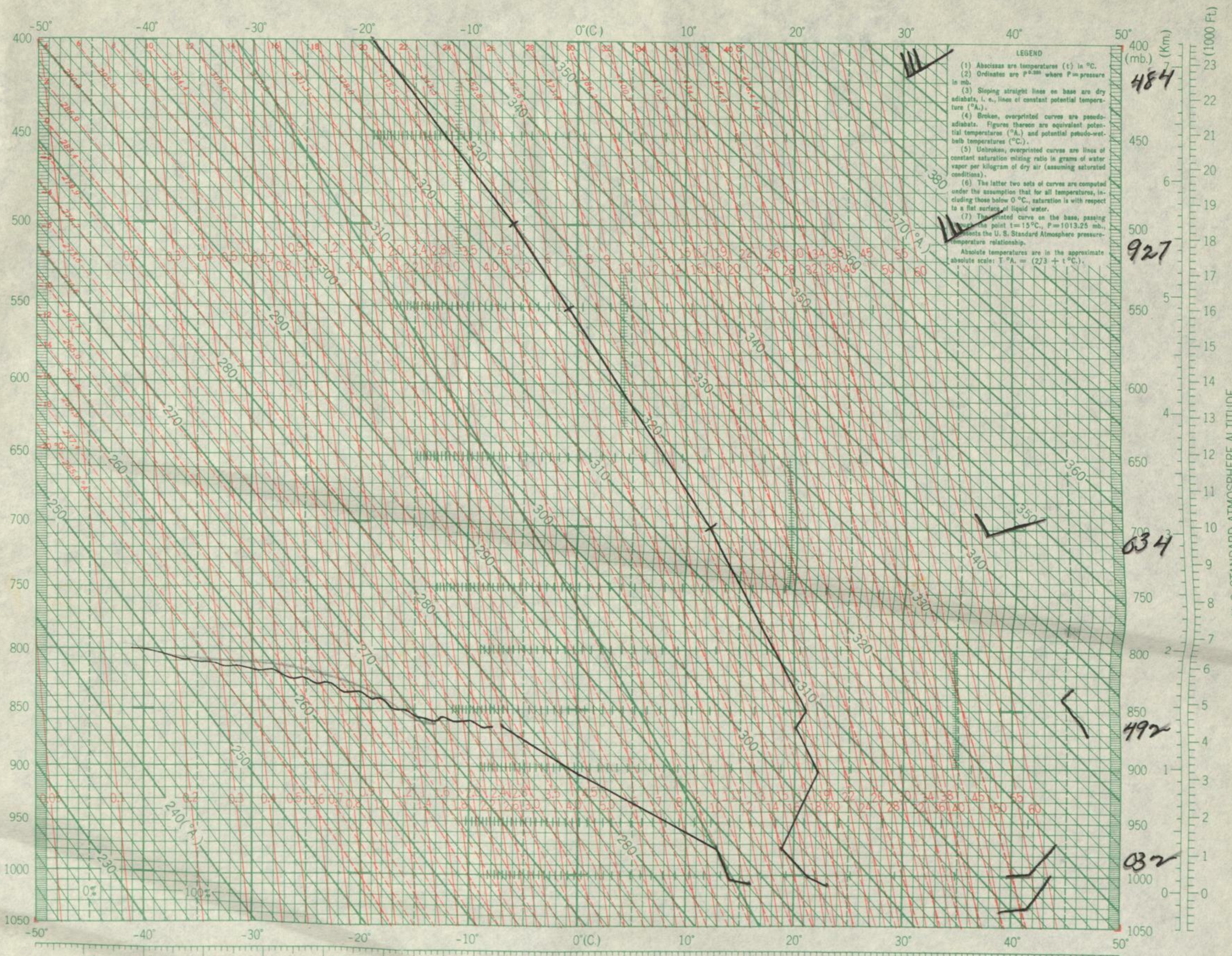
- (1) Abscissas are temperatures (t) in °C.
- (2) Ordinates are  $P^{0.2857}$  where P = pressure in mb.
- (3) Stopping straight lines on base are dry adiabats, i. e., lines of constant potential temperature (°A).
- (4) Broken, overprinted curves are pseudo-adiabats. Figures thereon are equivalent potential temperatures (°A) and potential pseudo-wet-bulb temperatures (°C).
- (5) Unbroken, overprinted curves are lines of constant saturation mixing ratio in grams of water vapor per kilogram of dry air (assuming saturated conditions).
- (6) The latter two sets of curves are computed under the assumption that for all temperatures, including those below 0 °C., saturation is with respect to a flat surface of liquid water.
- (7) The printed curves on the base, passing through the point (t = 15 °C., P = 1013.25 mb., represent the U. S. Standard Atmosphere pressure-temperature relationship.

Absolute temperatures are in the approximate absolute scale:  $T^{\circ A} = (273 + t^{\circ C})$ .

Station **LGB** Date (G.C.T.) **17 AUG '54** Hour (G.C.T.) **1900P**

PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

- (1) Abscissas are temperatures (t) in °C.
- (2) Ordinates are  $P^{0.2857}$  where P = pressure in mb.
- (3) Sloping straight lines on base are dry adiabats, i. e., lines of constant potential temperature (°A).
- (4) Broken, overprinted curves are pseudo-adiabats. Figures thereon are equivalent potential temperatures (°A) and potential pseudo-wet-bulb temperatures (°C).
- (5) Unbroken, overprinted curves are lines of constant saturation mixing ratio in grams of water vapor per kilogram of dry air (assuming saturated conditions).
- (6) The latter two sets of curves are computed under the assumption that for all temperatures, including those below 0 °C, saturation is with respect to a flat surface of liquid water.
- (7) The printed curve on the base, passing through the point t = 15°C, P = 1013.25 mb., represents the U. S. Standard Atmosphere pressure-temperature relationship.

Absolute temperatures are in the approximate absolute scale:  $T^{\circ A} = (273 + t^{\circ C})$ .

Station **LGB** Date (G.C.T.) **17 AUG '54** Hour (G.C.T.) **1300P**

TEMPERATURE

# PSEUDO-ADIABATIC CHART

LOWER LEVELS



Station LGB Date (G.C.T.) 17 AUG 54 Hour (G.C.T.) 0700 P

487

928

033

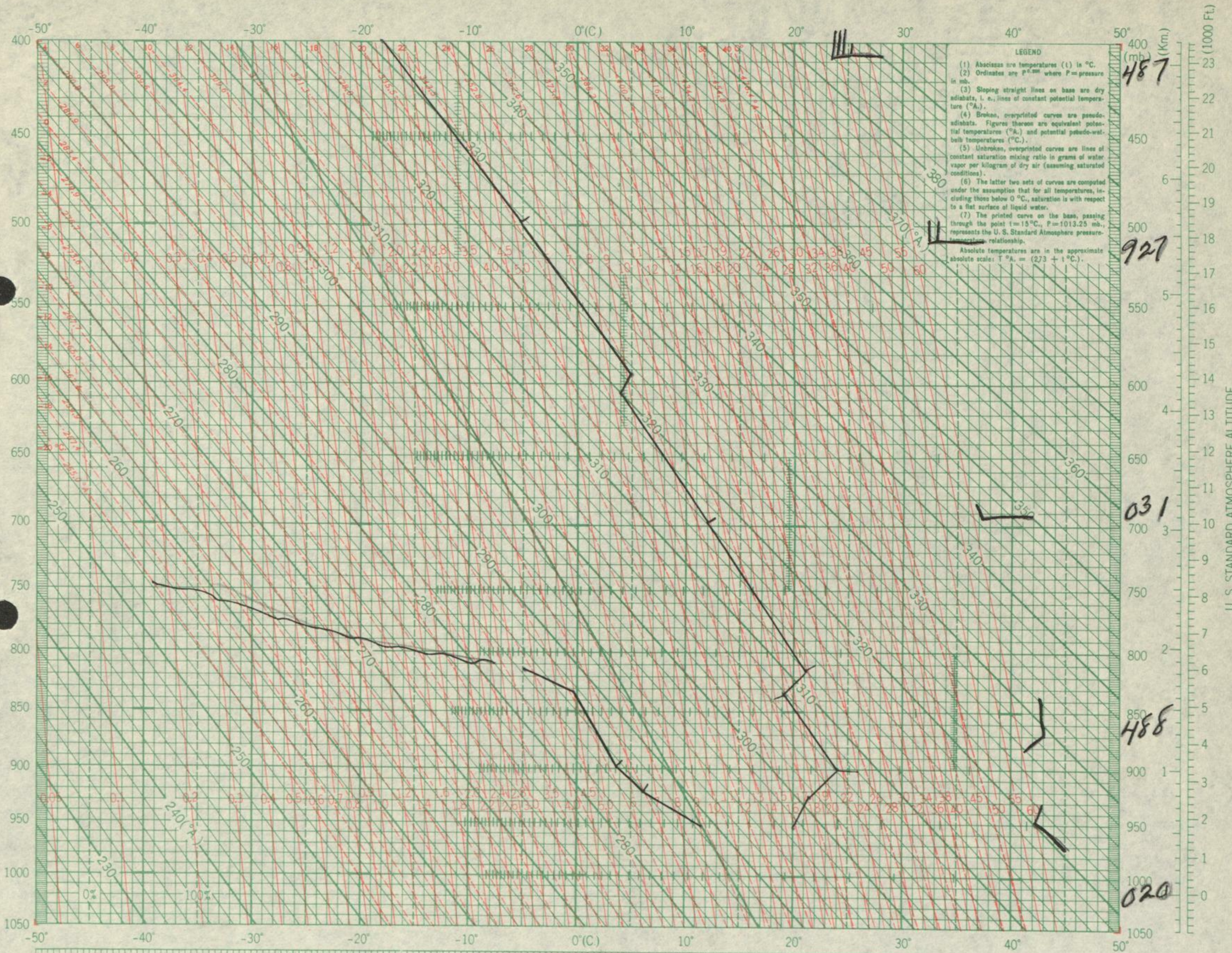
497

034

U. S. STANDARD ATMOSPHERE ALTITUDE

PSEUDO-ADIABATIC CHART

LOWER LEVELS



Station **RIV** Date (G.C.T.) **17 AUG '50** Hour (G.C.T.) **1900 P** TEMPERATURE

487

927

031

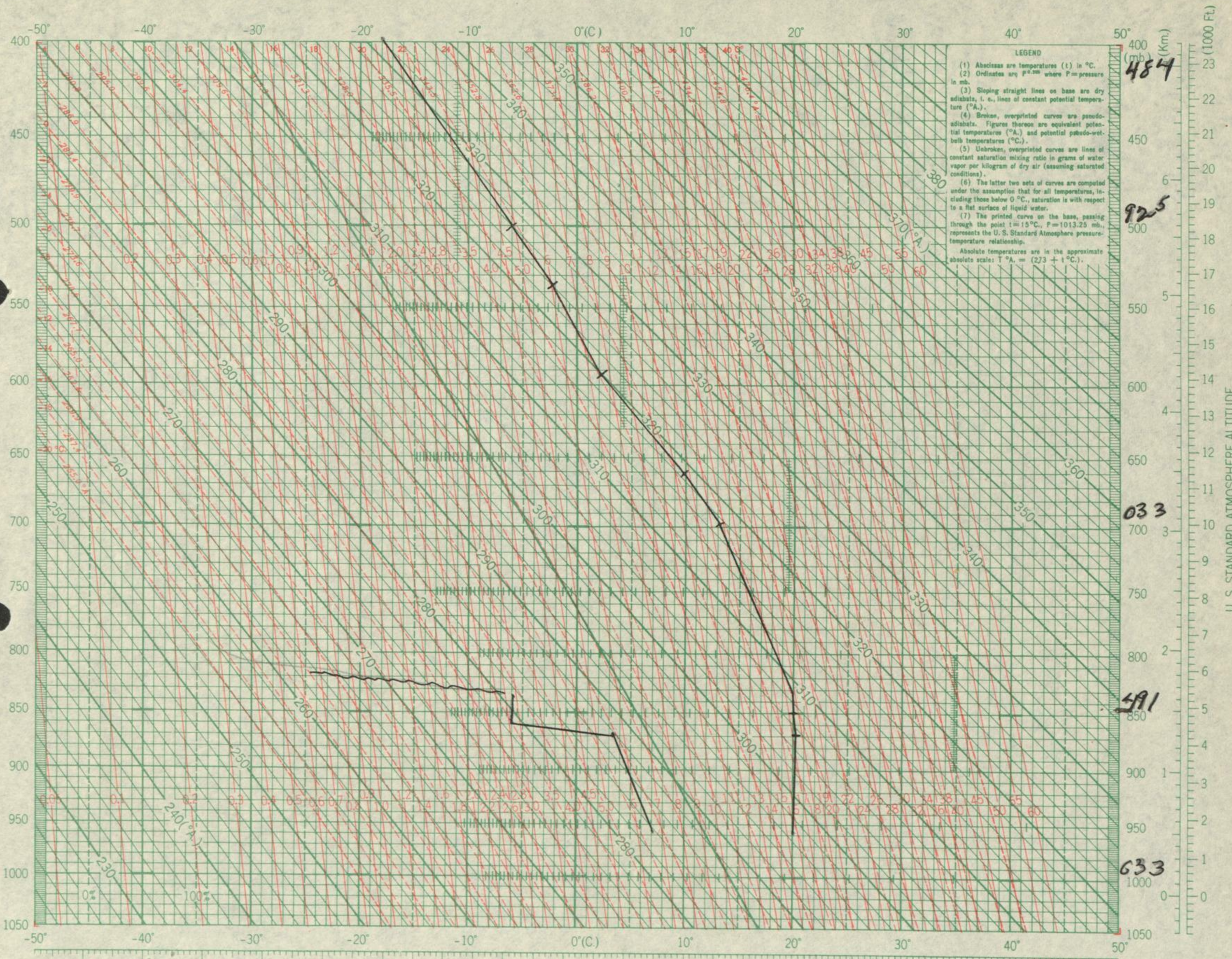
488

020

U. S. STANDARD ATMOSPHERE ALTITUDE

PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

- (1) Abscissas are temperatures (t) in °C.
- (2) Ordinates are P<sup>0.286</sup> where P = pressure in mb.
- (3) Sloping straight lines on base are dry adiabats, i. e., lines of constant potential temperature (°A).
- (4) Broken, overprinted curves are pseudo-adiabats. Figures thereon are equivalent potential temperatures (°A) and potential pseudo-wet-bulb temperatures (°C).
- (5) Unbroken, overprinted curves are lines of constant saturation mixing ratio in grams of water vapor per kilogram of dry air (assuming saturated conditions).
- (6) The latter two sets of curves are computed under the assumption that for all temperatures, including those below 0 °C., saturation is with respect to a flat surface of liquid water.
- (7) The printed curve on the base, passing through the point t = 15 °C., P = 1013.25 mb., represents the U. S. Standard Atmosphere pressure-temperature relationship.

Absolute temperatures are in the approximate absolute scale: T °A. = (273 + t °C).

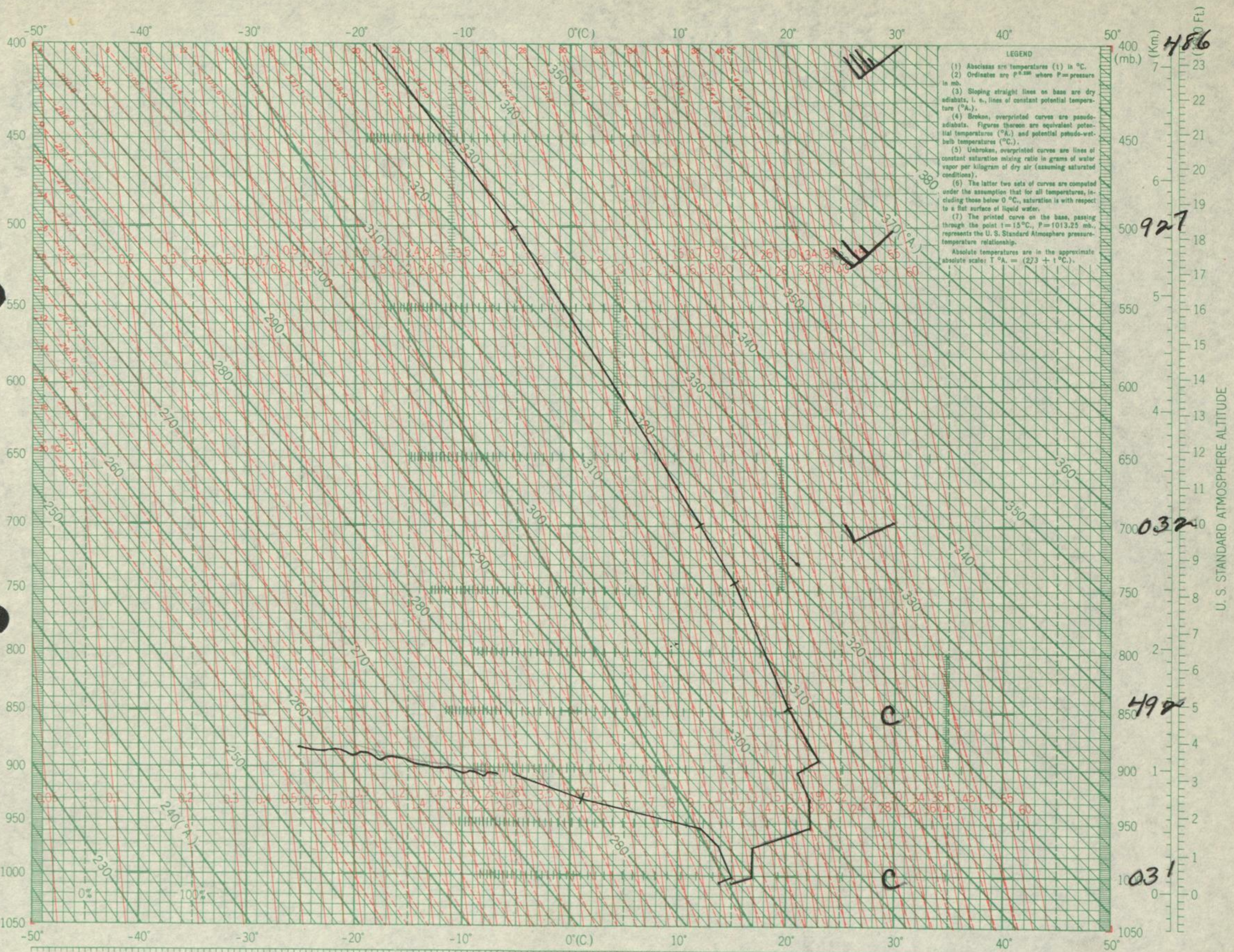
484  
925  
033  
491  
633

Station RIV Date (G.C.T.) 17 AUG 54 Hour (G.C.T.) 0700P

TEMPERATURE

# PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

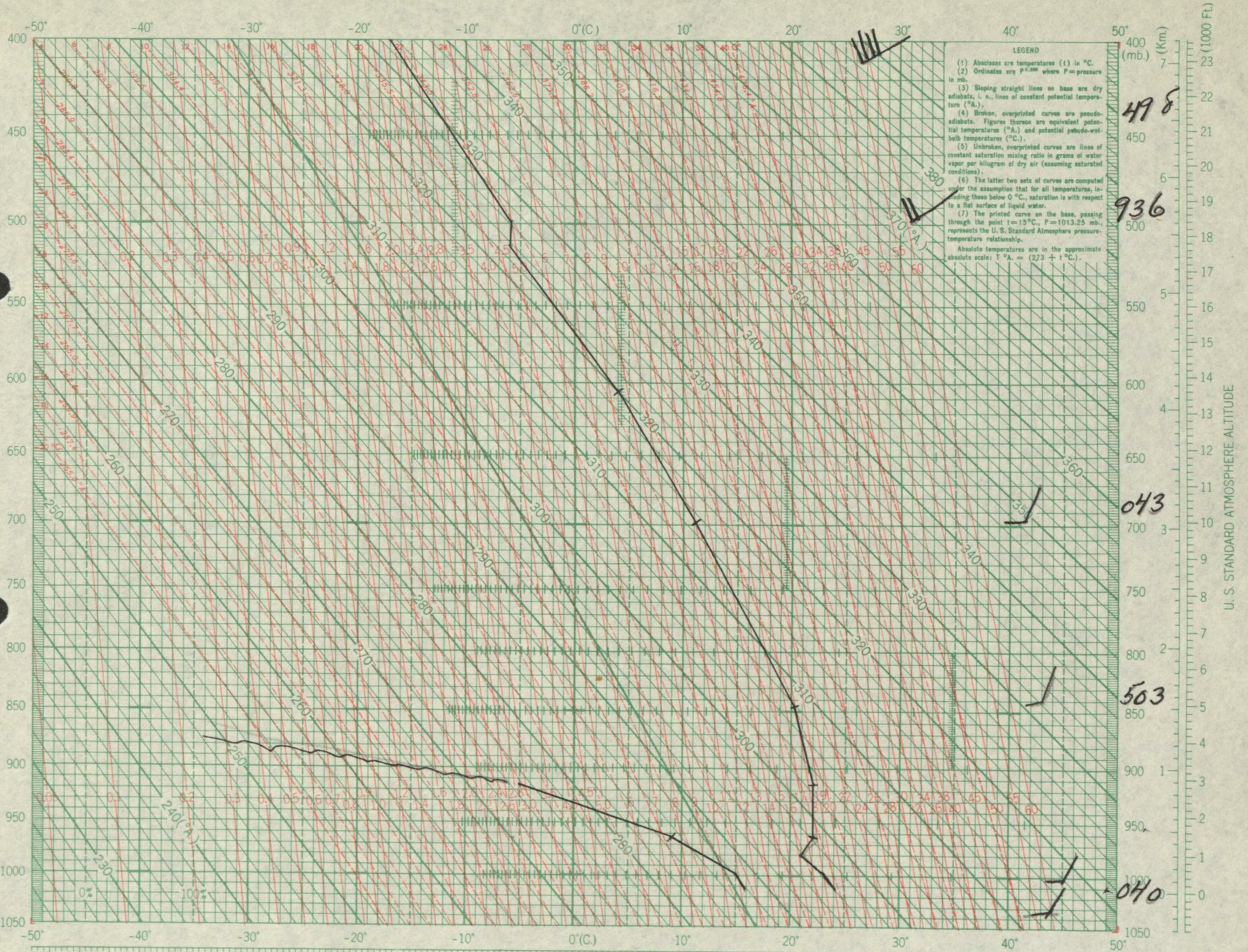
- (1) Abscissas are temperatures (t) in °C.
- (2) Ordinates are  $P^{0.286}$  where P = pressure in mb.
- (3) Sloping straight lines on base are dry adiabats, i. e., lines of constant potential temperature (°A).
- (4) Broken, overprinted curves are pseudo-adiabats. Figures thereon are equivalent potential temperatures (°A) and potential pseudo-wet-bulb temperatures (°C).
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- (7) The printed curve on the base, passing through the point  $t = 15^\circ\text{C}$ ,  $P = 1013.25$  mb., represents the U. S. Standard Atmosphere pressure-temperature relationship.

Absolute temperatures are in the approximate absolute scale:  $T^{\circ\text{A}} = (273 + t^{\circ\text{C}})$ .

Station **LGB** Date (G.C.T.) **17 AUG 1954** Hour (G.C.T.) **0100 P**

PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

- (1) Abscissas are temperatures (t) in °C.
- (2) Ordinates are  $P^{0.2857}$  where P=pressure in mb.
- (3) Sloping straight lines on base are dry adiabats, i. e., lines of constant potential temperature (°A.).
- (4) Broken, overprinted curves are pseudo-adiabats. Figures thereon are equivalent potential temperatures (°A.) and potential pseudo-wet-bulb temperatures (°C.).
- (5) Unbroken, overprinted curves are lines of constant saturation mixing ratio in grams of water vapor per kilogram of dry air (assuming saturated conditions).
- (6) The latter two sets of curves are computed under the assumption that for all temperatures, including those below 0 °C., saturation is with respect to a flat surface of liquid water.
- (7) The printed curves on the base, passing through the point  $t=15^{\circ}C, P=1013.25$  mb., represent the U. S. Standard Atmosphere pressure-temperature relationship.

Absolute temperatures are in the approximate absolute scale:  $T^{\circ A} = (273 + t^{\circ C})$ .

498

936

043

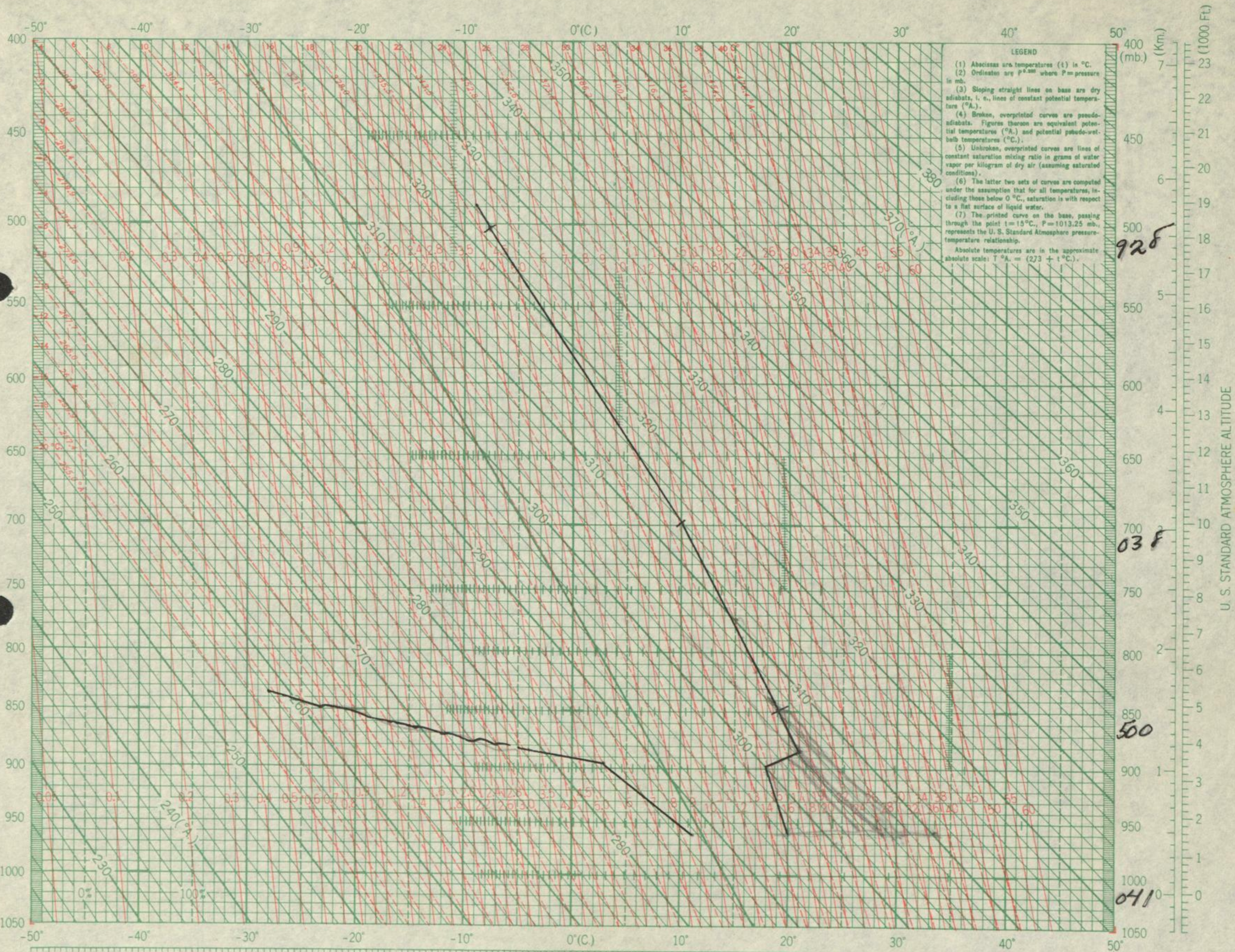
503

040

Station **LGB** Date (G.C.T.) **16 AUG 50** Hour (G.C.T.) **1300P** TEMPERATURE

# PSEUDO-ADIABATIC CHART

LOWER LEVELS



925

03 F

500

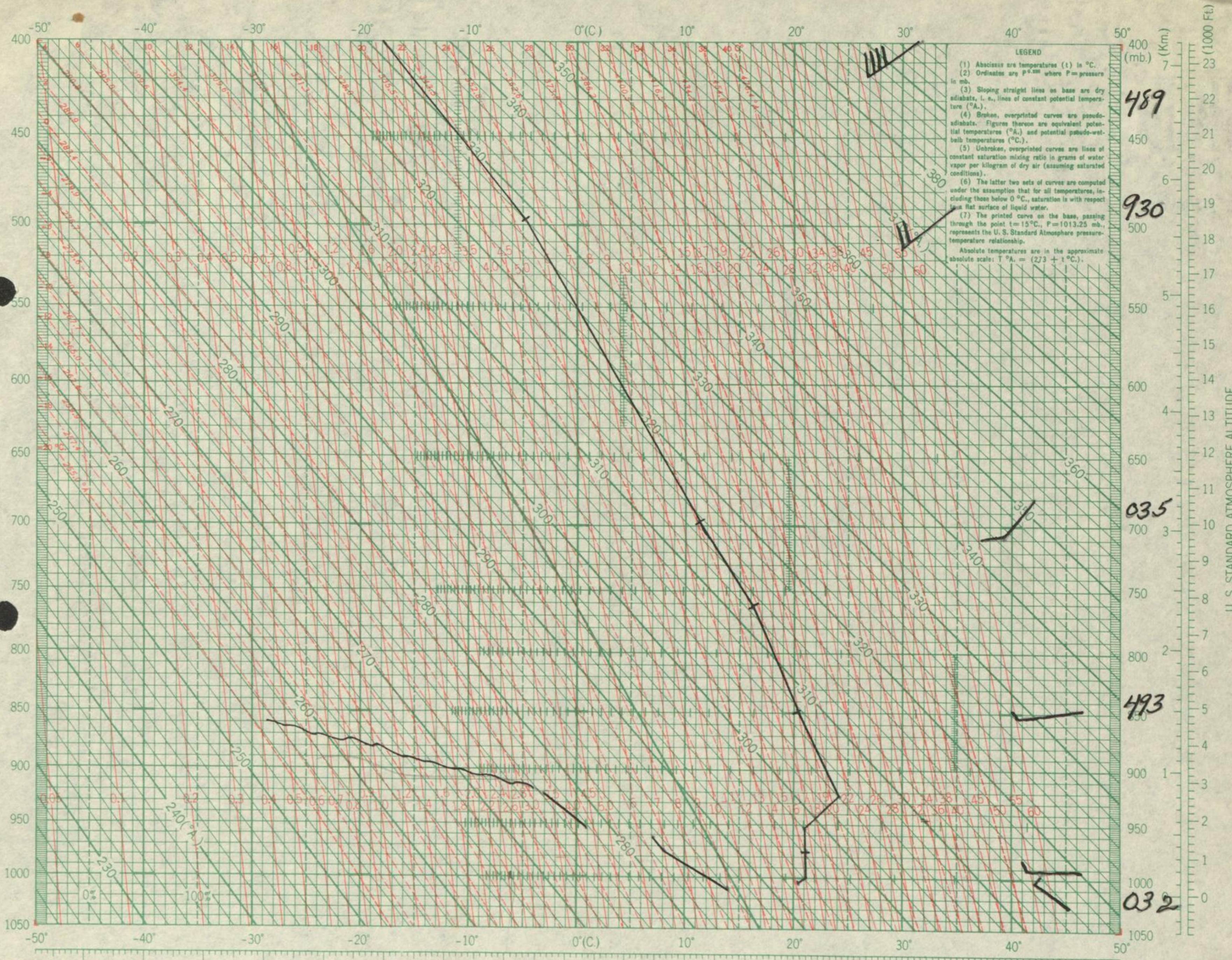
0410

Station RIV Date (G.C.T.) 16 AUG 54 Hour (G.C.T.) 6 200 P TEMPERATURE



# PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

- (1) Abscissae are temperatures (t) in °C.
- (2) Ordinates are  $P^{0.2857}$  where P = pressure in mb.
- (3) Sloping straight lines on base are dry adiabats, i. e., lines of constant potential temperature (°A.).
- (4) Broken, overprinted curves are pseudo-adiabats. Figures thereon are equivalent potential temperatures (°A.) and potential pseudo-wet-bulb temperatures (°C.).
- (5) Unbroken, overprinted curves are lines of constant saturation mixing ratio in grams of water vapor per kilogram of dry air (assuming saturated conditions).
- (6) The latter two sets of curves are computed under the assumption that for all temperatures, including those below 0 °C., saturation is with respect to a flat surface of liquid water.
- (7) The printed curve on the base, passing through the point  $t = 15^\circ\text{C}$ ,  $P = 1013.25$  mb., represents the U. S. Standard Atmosphere pressure-temperature relationship.

Absolute temperatures are in the approximate absolute scale:  $T^{\circ\text{A.}} = (273 + t^{\circ\text{C}})$ .

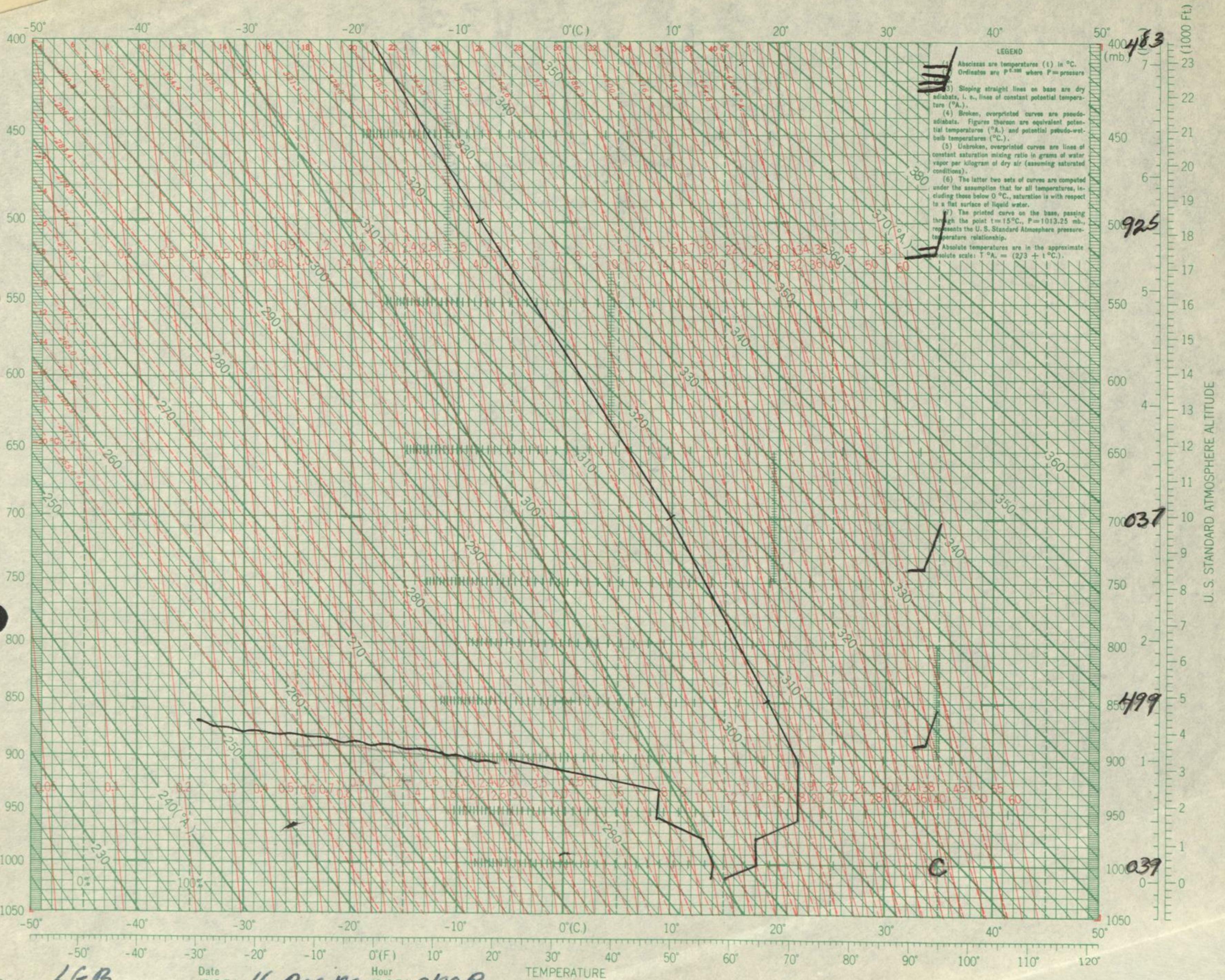
U. S. STANDARD ATMOSPHERE ALTITUDE

1.63 Date 16 AUG '54 Hour 1900 P  
 (G.C.T.) (G.C.T.)

TEMPERATURE

# PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

(1) Abscissas are temperatures (t) in °C. Ordinate is P<sup>0.285</sup> where P = pressure

(2) Sloping straight lines on base are dry adiabats, i. e., lines of constant potential temperature (°A.).

(3) Broken, overprinted curves are pseudo-adiabats. Figures thereon are equivalent potential temperatures (°A.) and potential pseudo-wet-bulb temperatures (°C.).

(4) Unbroken, overprinted curves are lines of constant saturation mixing ratio in grams of water vapor per kilogram of dry air (assuming saturated conditions).

(5) The latter two sets of curves are computed under the assumption that for all temperatures, including those below 0 °C., saturation is with respect to a flat surface of liquid water.

(6) The printed curve on the base, passing through the point t = 15°C., P = 1013.25 mb., represents the U. S. Standard Atmosphere pressure-temperature relationship.

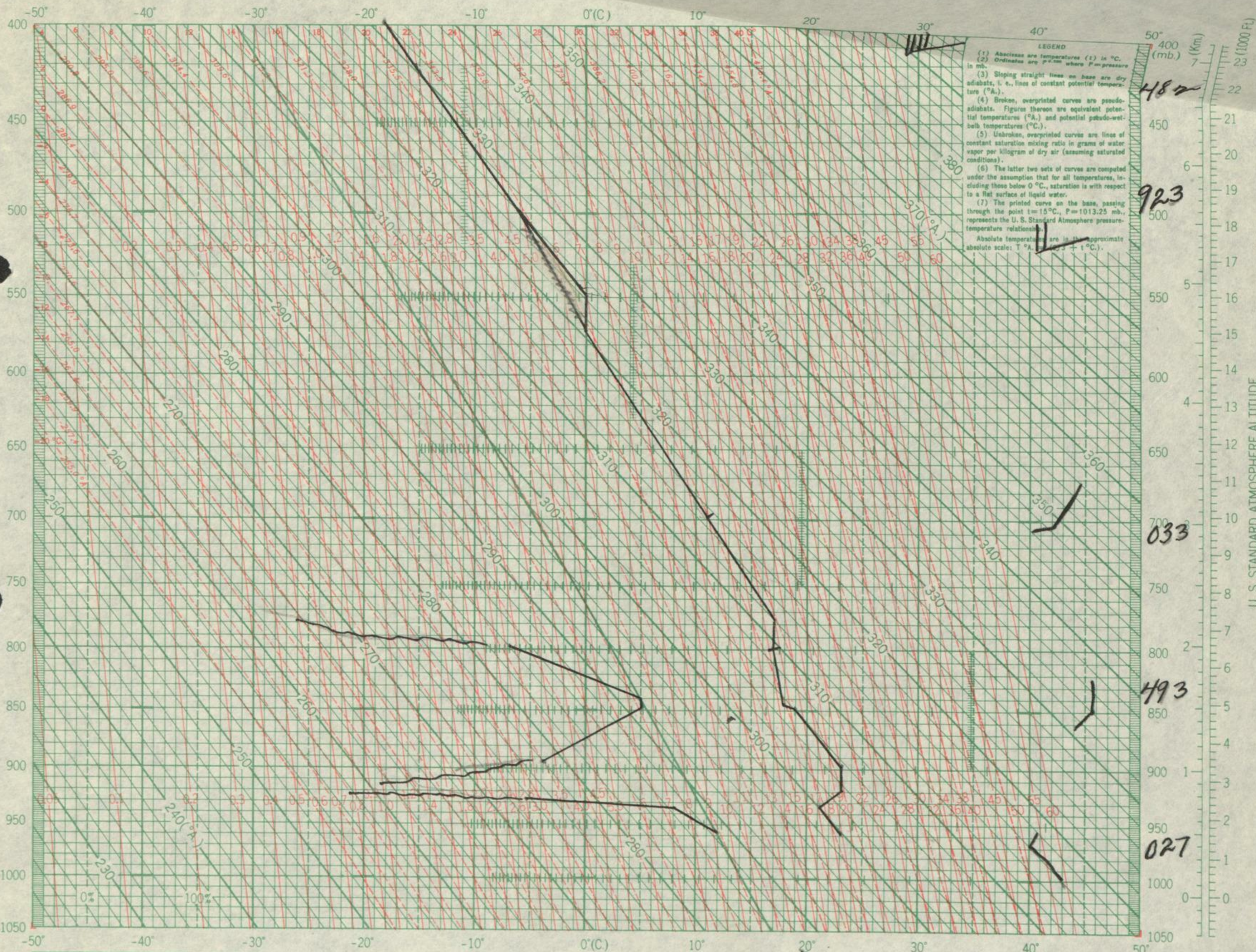
(7) Absolute temperatures are in the approximate scale: T<sup>°A.</sup> = (273 + t °C.).

Station LGB Date (G.C.T.) 16 AUG 1954 Hour (G.C.T.) 0100 P

U. S. STANDARD ATMOSPHERE ALTITUDE

400 **483** (mb.)  
 450  
 500 **925**  
 550  
 600  
 650  
 700 **037**  
 750  
 800  
 850 **499**  
 900  
 950  
 1000 **039**  
 1050

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU  
PSEUDO-ADIABATIC CHART  
LOWER LEVELS



482

923

033

493

027

Station RIV Date (G.C.T.) 16 AUG 54 Hour (G.C.T.) 1900 P TEMPERATURE

(Revised Dec. 1950)

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

# PSEUDO-ADIABATIC CHART

LOWER LEVELS



Station **LGB** Date (G.C.T.) **15 AUG 54** Hour (G.C.T.) **1900** TEMPERATURE

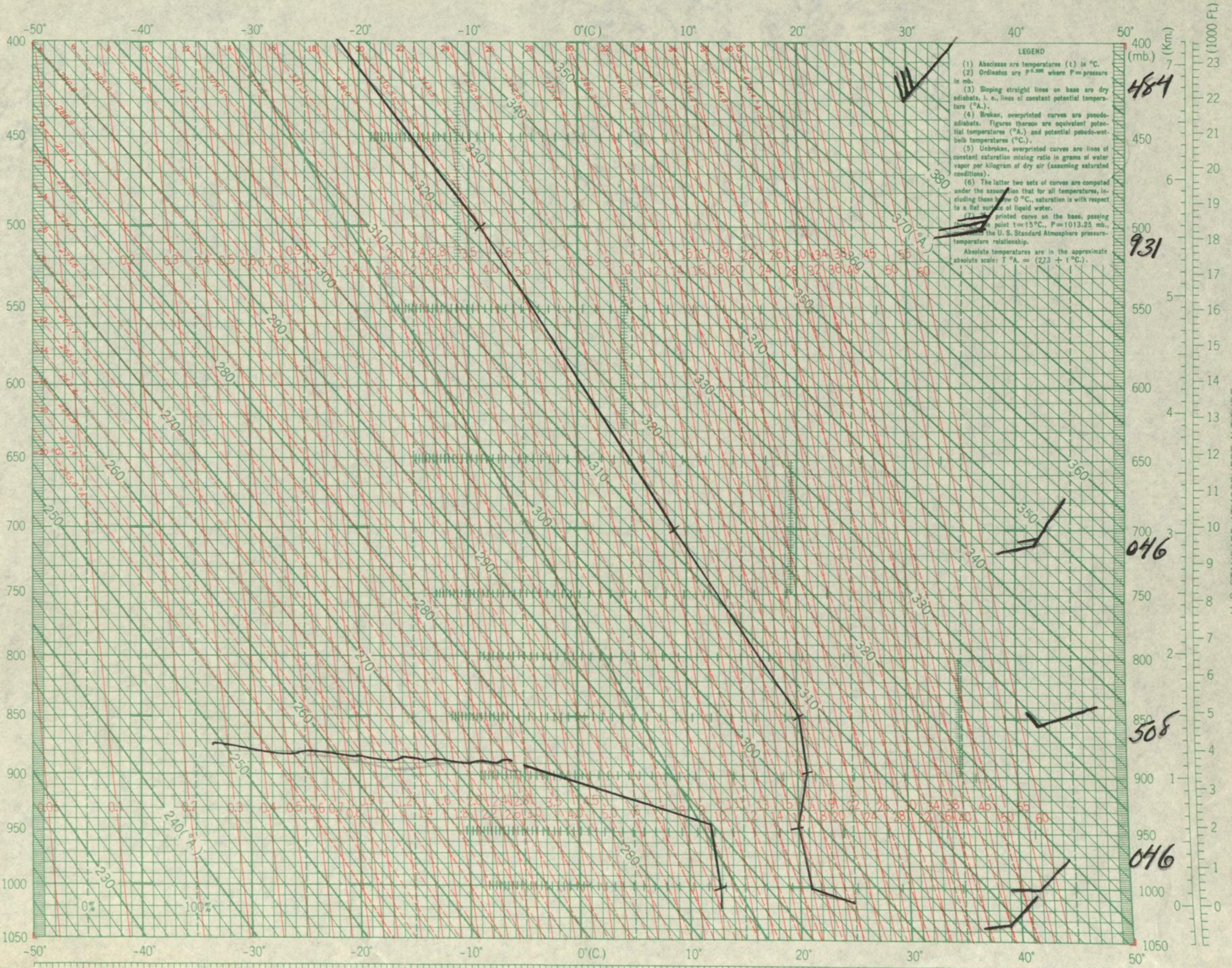
400 (mb) **487**  
 450  
 500 **926**  
 550  
 600  
 650  
 700 **040**  
 750  
 800  
 850 **501**  
 900  
 950 **040**  
 1000  
 1050

(1000 Ft.)  
 23  
 22  
 21  
 20  
 19  
 18  
 17  
 16  
 15  
 14  
 13  
 12  
 11  
 10  
 9  
 8  
 7  
 6  
 5  
 4  
 3  
 2  
 1  
 0

U. S. STANDARD ATMOSPHERE ALTITUDE

PSEUDO-ADIABATIC CHART

LOWER LEVELS



484

931

046

508

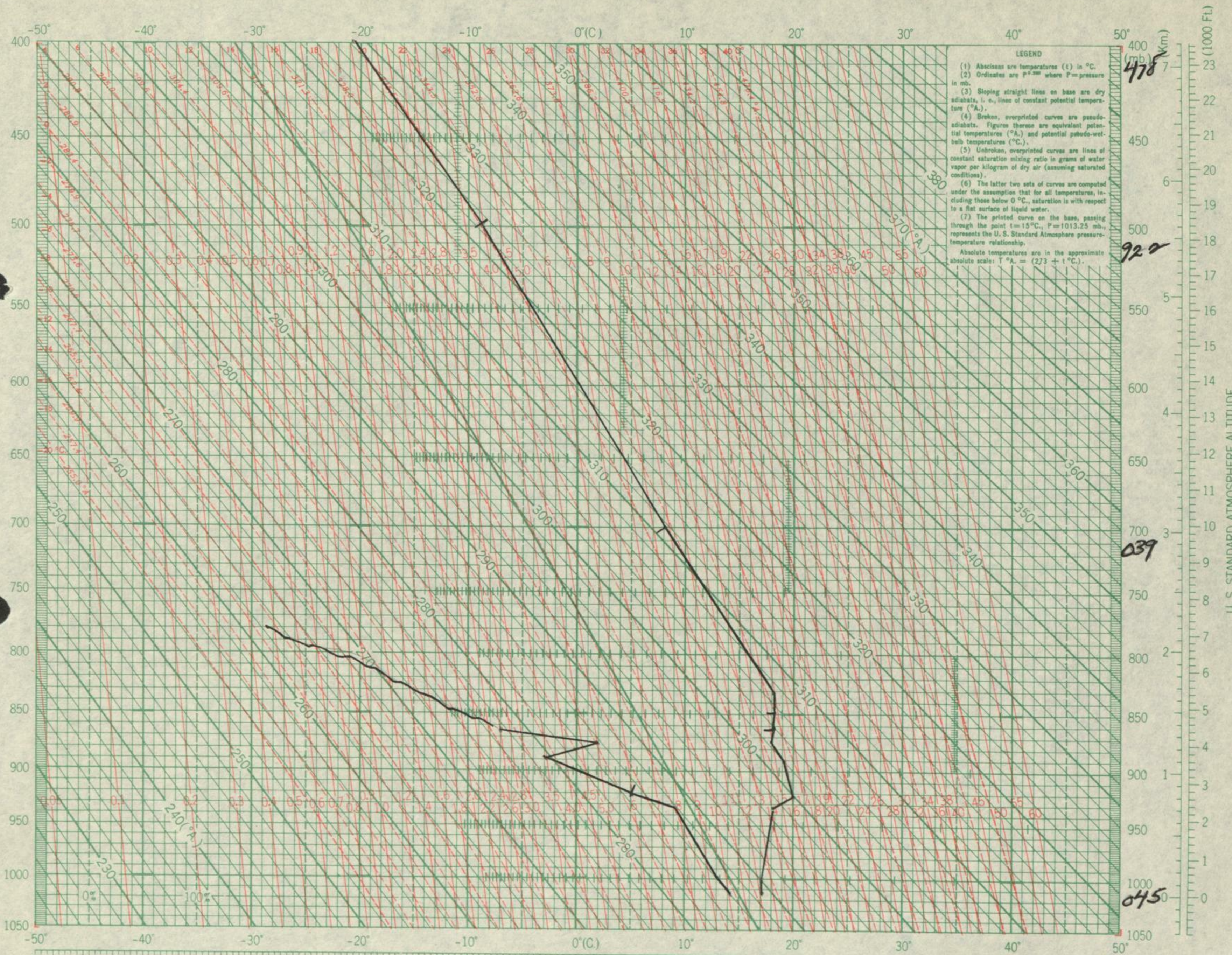
046

Station LGB Date (G.C.T.) 1300P Hour (G.C.T.) 14 AUG '54 TEMPERATURE

U. S. STANDARD ATMOSPHERE ALTITUDE

# PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

- (1) Abscissas are temperatures (t) in °C.
- (2) Ordinates are  $P^{0.2857}$  where P = pressure in mb.
- (3) Sloping straight lines on base are dry adiabats, i. e., lines of constant potential temperature (°A).
- (4) Broken, overprinted curves are pseudo-adiabats. Figures thereon are equivalent potential temperatures (°A.) and potential pseudo-wet-bulb temperatures (°C.).
- (5) Unbroken, overprinted curves are lines of constant saturation mixing ratio in grams of water vapor per kilogram of dry air (assuming saturated conditions).
- (6) The latter two sets of curves are computed under the assumption that for all temperatures, including those below 0 °C., saturation is with respect to a flat surface of liquid water.
- (7) The printed curve on the base, passing through the point  $t = 15^\circ\text{C}$ ,  $P = 1013.25$  mb., represents the U. S. Standard Atmosphere pressure-temperature relationship.

Absolute temperatures are in the approximate absolute scale:  $T^{\circ\text{A.}} = (273 + t^{\circ\text{C}})$ .

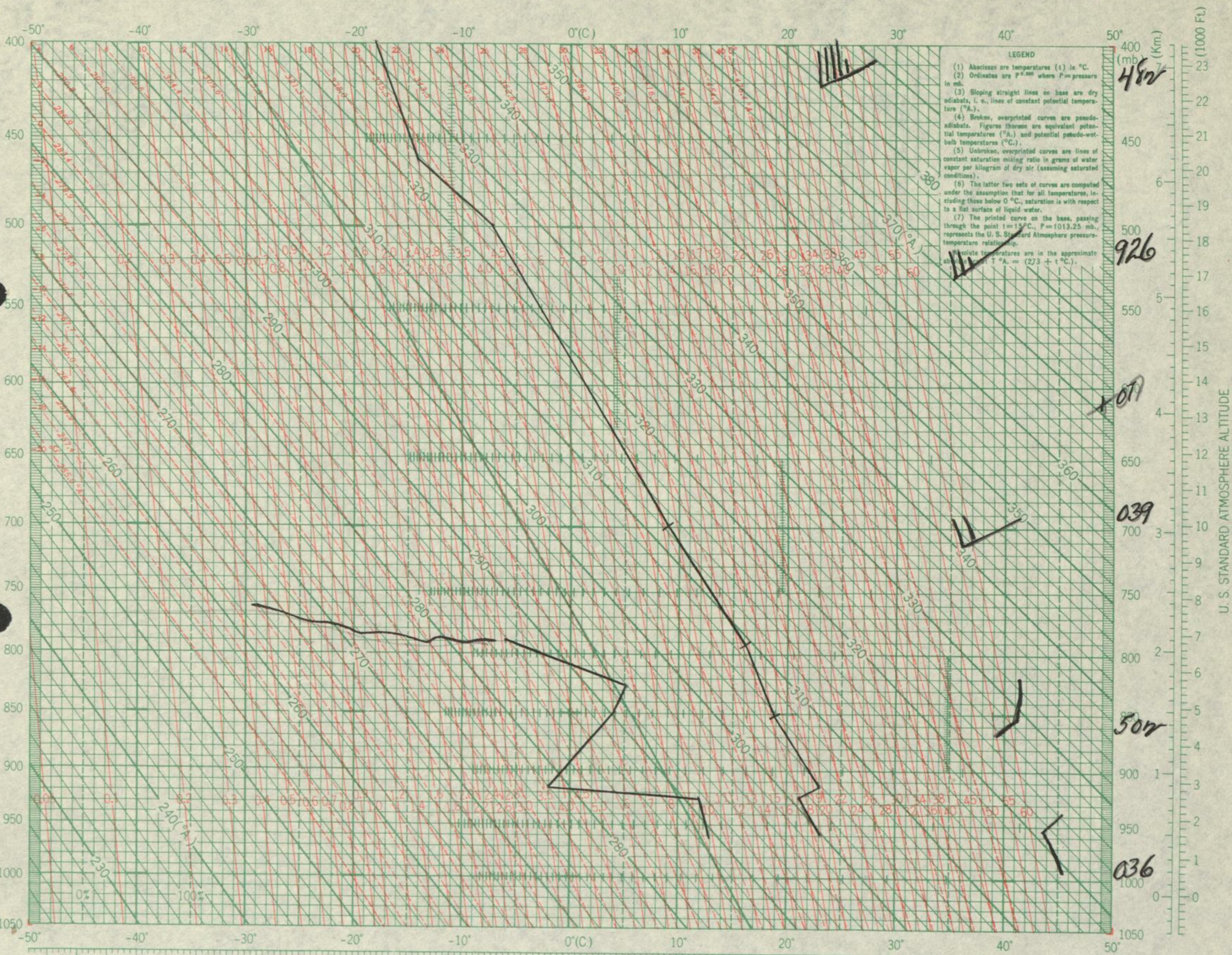
Station **LGB** Date (G.C.T.) **15 AUG 50** Hour (G.C.T.) **0700P**

Handwritten notes on the right side of the chart:

- 478 (at 400 mb)
- 922 (at 500 mb)
- 039 (at 750 mb)
- 045 (at 1000 mb)

PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

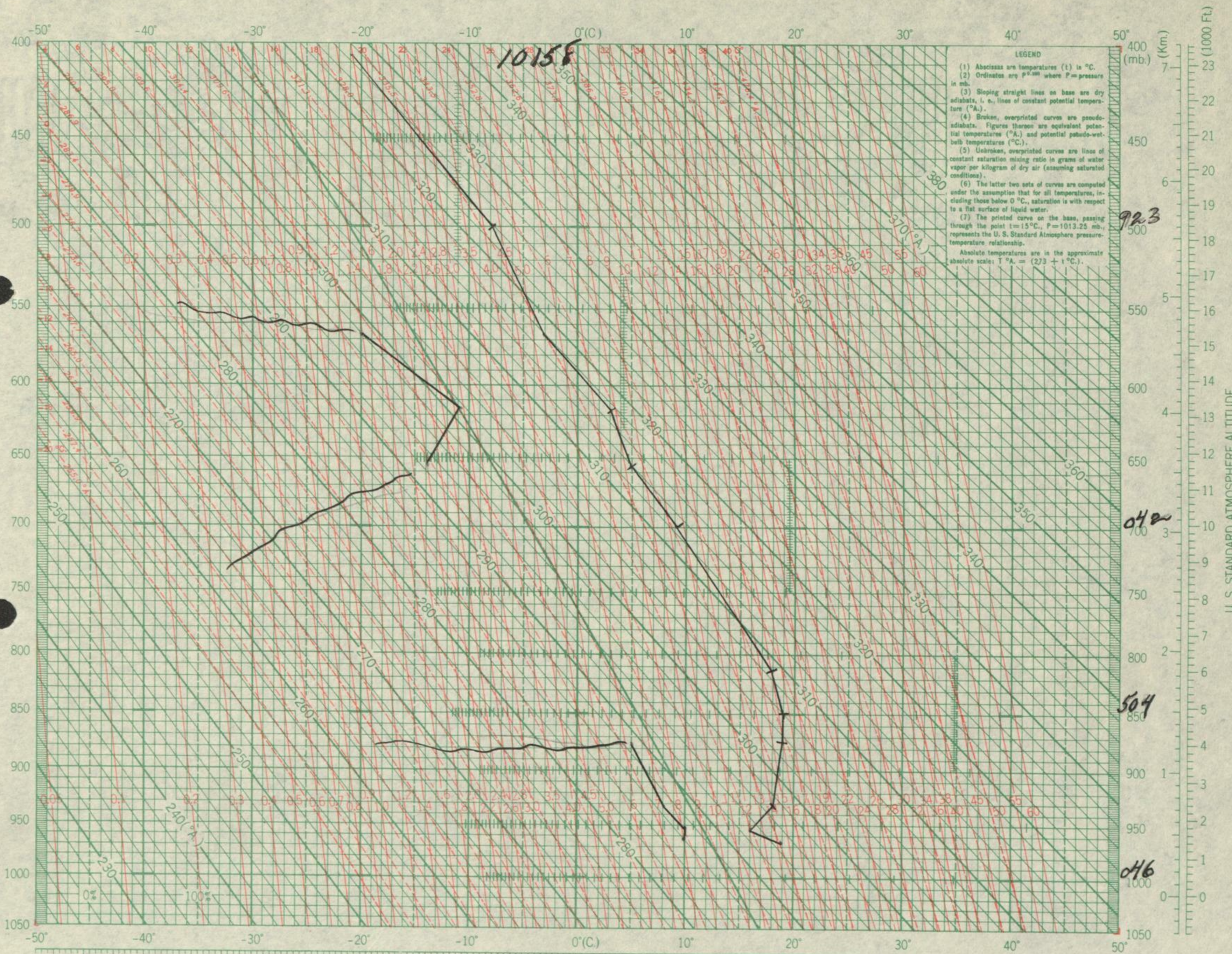
- (1) Abscissas are temperatures (t) in °C.
- (2) Ordinates are  $P^{0.286}$  where P = pressure in mb.
- (3) Sloping straight lines on base are dry adiabats, i. e., lines of constant potential temperature (°A.).
- (4) Broken, overprinted curves are pseudo-adiabats. Figures thereon are equivalent potential temperatures (°A.) and potential pseudo-wet-bulb temperatures (°C.).
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- (6) The latter two sets of curves are computed under the assumption that for all temperatures, including those below 0 °C., saturation is with respect to a flat surface of liquid water.
- (7) The printed curve on the base, passing through the point  $t = 15^\circ\text{C}$ ,  $P = 1013.25$  mb., represents the U. S. Standard Atmosphere pressure-temperature relationship.

Relative temperatures are in the approximate relation  $T^{\circ\text{A.}} = (273 + t^{\circ\text{C}})$ .

Station P11U Date (G.C.T.) 15 AUG 54 Hour (G.C.T.) 1900 P TEMPERATURE

# PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

- (1) Abscissas are temperatures ( $t$ ) in  $^{\circ}\text{C}$ .
- (2) Ordinates are  $P^{0.285}$  where  $P$  = pressure in mb.
- (3) Sloping straight lines on base are dry adiabats, i. e., lines of constant potential temperature ( $^{\circ}\text{A}$ ).
- (4) Broken, overprinted curves are pseudo-adiabats. Figures thereon are equivalent potential temperatures ( $^{\circ}\text{A}$ ) and potential pseudo-wet-bulb temperatures ( $^{\circ}\text{C}$ ).
- (5) Unbroken, overprinted curves are lines of constant saturation mixing ratio in grams of water vapor per kilogram of dry air (assuming saturated conditions).
- (6) The latter two sets of curves are computed under the assumption that for all temperatures, including those below  $0^{\circ}\text{C}$ , saturation is with respect to a flat surface of liquid water.
- (7) The printed curve on the base, passing through the point  $t = 15^{\circ}\text{C}$ ,  $P = 1013.25$  mb, represents the U. S. Standard Atmosphere pressure-temperature relationship.

Absolute temperatures are in the approximate absolute scale:  $T^{\circ}\text{A} = (273 + t^{\circ}\text{C})$ .

Station RIV Date (G.C.T.) 15 AUG 54 Hour (G.C.T.) 0700 P



PSEUDO-ADIABATIC CHART

LOWER LEVELS



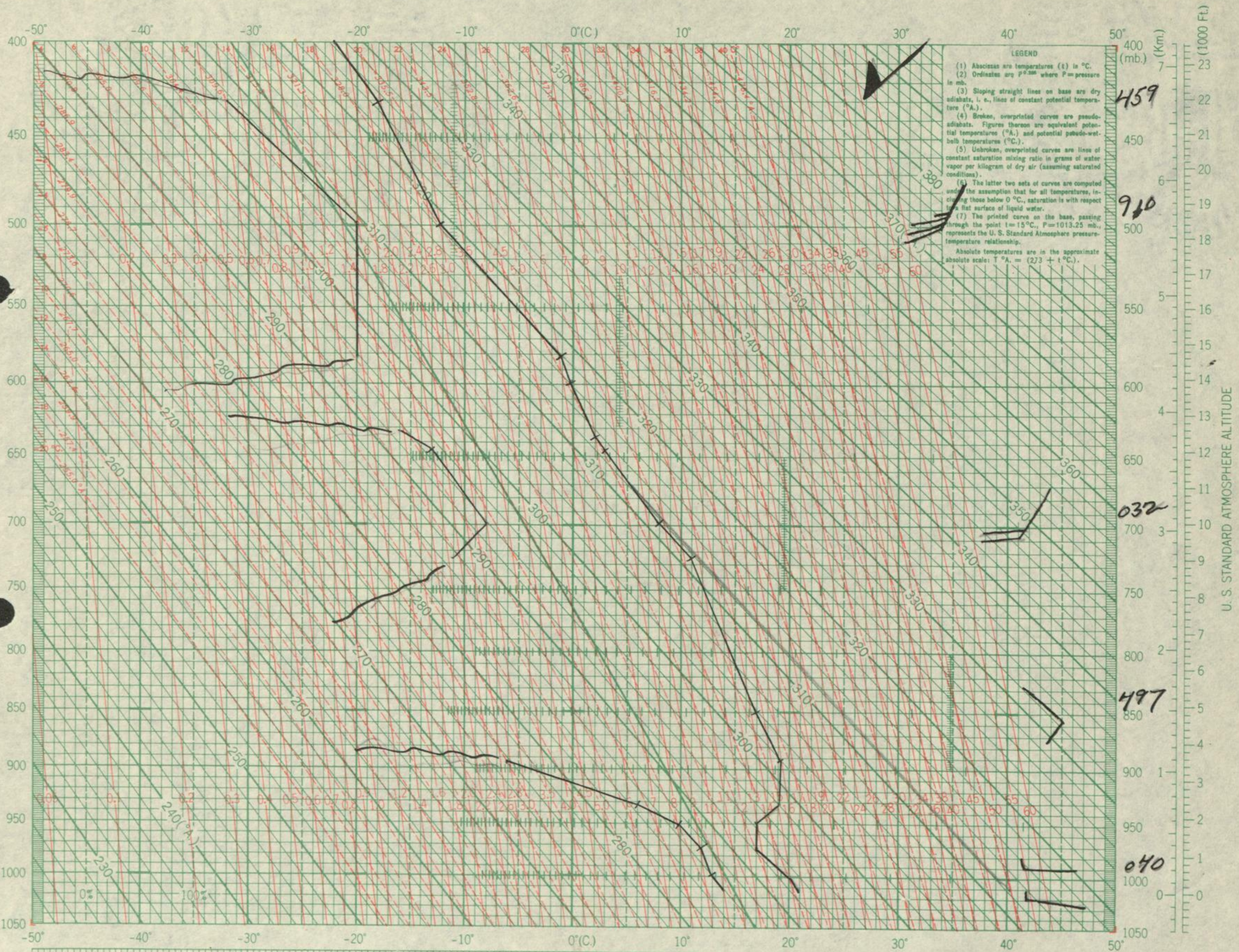
Station LGB Date (G.C.T.) 15 AUG '54 Hour (G.C.T.) 0100P

TEMPERATURE

U. S. STANDARD ATMOSPHERE ALTITUDE

PSEUDO-ADIABATIC CHART

LOWER LEVELS



Station LGB Date (G.C.T.) 14 AUG 54 Hour (G.C.T.) 1900P

459

910

032

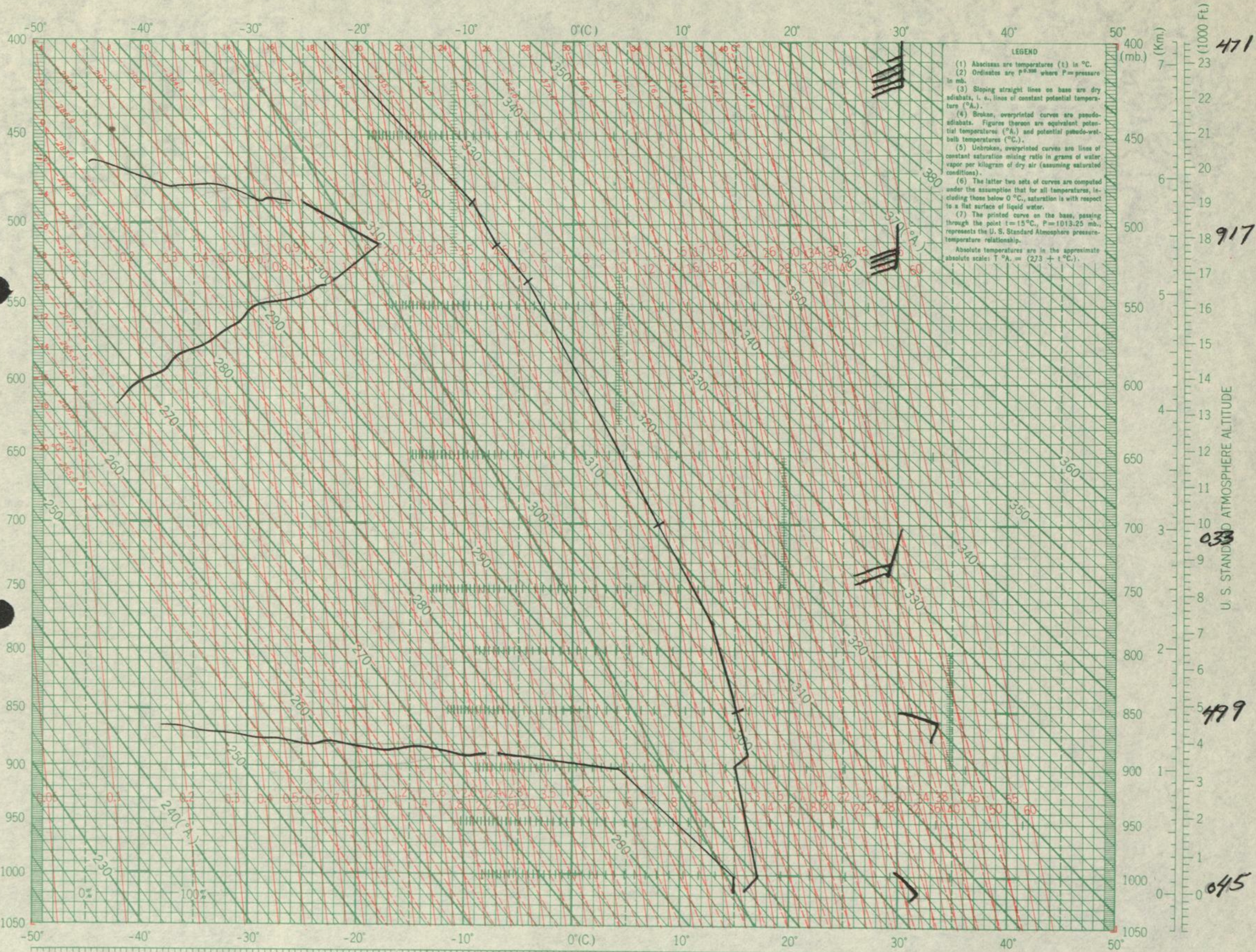
497

040

U. S. STANDARD ATMOSPHERE ALTITUDE

PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

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- (2) Ordinates are  $P^{0.286}$  where P=pressure in mb.
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- (7) The printed curve on the base, passing through the point t=15°C., P=1013.25 mb., represents the U. S. Standard Atmosphere pressure-temperature relationship.

Absolute temperatures are in the approximate absolute scale:  $T^{\circ A.} = (273 + t^{\circ C.})$ .

Station LGB Date (G.C.T.) 14 AUG 1954 Hour (G.C.T.) 0100 P

TEMPERATURE

U. S. STANDARD ATMOSPHERE ALTITUDE

PSEUDO-ADIABATIC CHART

LOWER LEVELS



Station RIV Date (G.C.T.) 14 Aug '54 Hour (G.C.T.) 1900 P

460

910

033

498

040

U. S. STANDARD ATMOSPHERE ALTITUDE

PSEUDO-ADIABATIC CHART

LOWER LEVELS



**LEGEND**

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- (7) The printed curve on the base, passing through the point t=15°C., P=1013.25 mb., represents the U. S. Standard Atmosphere pressure-temperature relationship.

Absolute temperatures are in the approximate absolute scale:  $T^{\circ}A. = (273 + t^{\circ}C.)$ .

400 (mb.) 4146  
 450  
 500 917  
 550  
 600  
 650  
 700 034  
 750  
 800  
 850 499  
 900  
 950  
 1000 018  
 1050

U. S. STANDARD ATMOSPHERE ALTITUDE

Station **LGB** Date **14 AUG 54** Hour **0700 P**

TEMPERATURE