RESTRICTED

WEATHER SERVICE
Bulletin

ARMY AIR FORCES HEADQUARTERS WEATHER WING
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RESTRICTED

THE ROLE OF WEATHER IN AVIATION

A forecaster can improve the service which he renders to Weather's clients by studying the nature of their duties. Although a forecaster seldom must serve as an aircrewman or an operations officer, it is important that he investigate the actual use of weather information made by these aviators. Such a background guides him to select the appropriate manner, the efficient form, and the pertinent details for an excellent weather briefing.

*The weatherman has wide opportunity each day to familiarize himself with the duties of base operations and flying personnel. The conversations shared with them and their physical presence near the weather station contribute to such an understanding. Familiarization flights serve a like purpose. But even beyond these associations, the forecaster would profit from reading the publications at hand which discuss the relationship of weather to flying. In particular, high recommendation can be made of certain sections in the following:**

AAF Manual *55-2, "Manual for Base Operations Officers"*

"Pilots' Information File"

"Radio Operators' Information File"

"Navigators' Information File"

"Bombardiers' Information File"

"Aircraft Dispatching and Briefing"

These handbooks are prepared by military aviation experts whose view of weather and the Service is derived largely from experience in receiving and using forecasts. Their opinions, their advice, and their instructions to colleagues reveal their attitudes toward the forecaster and his job.

The forecaster who learns, "How does my client use the information I give?" and "What does he think of my work?" will be equipped to work with him on a common basis of understanding.

*These booklets can be obtained from the base operations officer. They are not available through regular publications channels, however.

J. W. Twaddell Jr.
Colonel, AC
Commanding

SELECTIONS FROM "MANUAL FOR BASE OPERATIONS OFFICERS"

WEATHER OFFICE

"A well-displayed sign should point the way to the weather office. Arrangement of data in the weather office and the service offered the pilot there has a great deal to do with the soundness of his clearance.

"Weather personnel must be given notice of the pilot's flight as early as possible in order to be ready with pertinent information.

"Special studies are being made by the weather organization to give the best possible service. Operations officers are charged with the duty of conferring and cooperating with weather officers to improve procedure , arrangement of materials, and service offered. It is the obligation of the operations officer to report immediately all criticisms of weather service to the weather officer and to aid in determining constructive action to be taken.

WEATHER OFFICER
(AAF Regulations, 105-Series)

"There must be constant liaison and consideration of mutual problems between the weather office and the operations office. Here again the operations officer is dealing with an independent but related organization. He must work with and through the weather officer at all times. Here are some of the mutual problems to be considered:

1. Service offered to the pilot in the weather office.
2. Cooperation between weather and clearance personnel.
3. Location of weather office in relation to the clearance office.
4. Logical display of weather data in the weather office.
5. Routing and use of Form 37.
6. Warning to the control tower and operations office of the approach of violent weather, such as hail, high winds, hurricanes, etc.
7. Use of weather aircraft.
8. Scheduling of flights for personnel of the weather office.
9. Instruction of clearance personnel in weather problems affecting clearances.
10. Analysis of weather as a contributing factor to accidents."

The value of an airport is often limited by the poor orientation of its runways with respect to dangerous winds, which blow across the fixed paths of takeoff and landing more frequently than is necessary. Aircraft operations are not hindered by relatively high winds which parallel a runway; but when that parallelism does not exist, even lower speeds become critical. Major Solot shows how conventional methods for considering climate in airport design are not always effective, and with examples he describes a comprehensive method which has been confirmed by experience in the Near East.

AIRPORT DESIGN

Major SAMUEL SOLOT
19th Weather Squadron

A general practice among designers of airfields has been to construct a principal runway along the prevailing wind direction, and to add others in an arbitrary symmetrical pattern. The "wind rose" diagram has been a pernicious influence in this matter: planners have assumed that runways layed parallel to the longest barb on a wind rose serve aircraft operations most effectively. But that theory overlooks the fact that the prevailing surface wind for many stations is light---unimportant to flying safety. And at the same time it ignores the danger of certain violent winds; for when supercritical wind speeds originate from a low frequency direction, their ominous nature is hidden within the rose diagram.

Incomplete planning is most serious when landing fields are spaced far apart. Then an airport can't be "closed". Several fatal accidents have taken place in the Sahara during emergency blind landings when strong winds were blowing across the runway. These accidents might well be attributed to "engineering error".

The principal reasons for inefficient layout of runways are two: (1) systematic local wind observations for new airport sites usually are scanty. Expert care and judgment in the study of wind data are especially necessary when data are scarce. (2) Indiscriminate use often is made of monthly and annual wind roses, which are misleading because they emphasize the *prevailing* and not the *critical* winds. Nevertheless, the experience of the 19th Weather Squadron proves that meteorologists can determine the most efficient runway orientations from limited data.

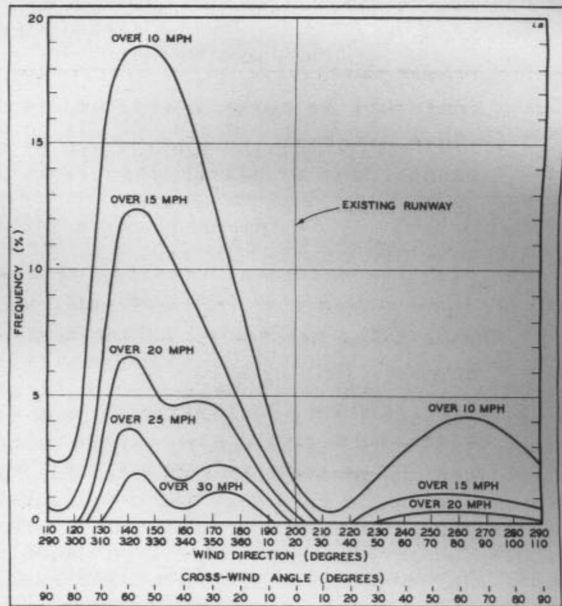


Figure 1: The single runway of an actual U.S. airport in the Near East, built parallel to the annual prevailing wind, is appropriate for use only during eight months of the year. In the winter (these curves are drawn from November obs) the airstrip has crosswinds whenever the speeds are dangerous! The best orientation for an additional runway would be 140-320°.

As the building program at an airport proceeds, remedial measures become increasingly expensive. Hence, the more value a field attains as a capital investment through the years, the more inevitably do its basic design defects become frozen. For this reason it is important for the meteorologist to make his analysis as soon as possible.

A practical analysis of runway design requires three distinct steps: becoming familiar with the problem from the engineer's view point, sampling the data, and making a statistical analysis.

I. *Grasping The Problem:*

A conference with the responsible engineer is a necessity, so that the weatherman can explain the value of his report and obtain information about the engineering problem involved.

II. *Sampling of Wind Data*

The weatherman must consider the representativeness of his data, looking for discrepancies caused by inadequate instrument exposure. He should critically examine detailed samples with regard to their meteorological significance, interpreting them in terms of specific weather situations instead of climatological

Table I: *Speed Distribution of SE and NW Surface Winds Combined at Station B---, based on 699 observations.*

Speed in mph	1-9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Number of Obs	45	18	8	20	14	10	21	9	12	6	9	6	5	3	1	1	7	1	2	3	0	1
Cumulative Total	202	157	139	131	111	97	87	66	57	45	39	30	24	19	16	15	14	7	6	4	1	1
Frequency, in %	29	23	20	19	16	14	12	9	8	6	6	4	3	3	2	2	2	1	*	*	*	*

(*indicates less than 1%.)

generalities. (This task requires a background of experience in the region.)

III. *Statistical Analysis*

The detailed procedures of the analysis should be adapted to the specific problem. In general, however, the first step is to tabulate four classifications of data (Table 1) for each of eight wind directions. Runways are bi-directional, of course, and so 16 points of the compass can be treated as 8 pairs of directions. The tabulation for each "bi-direction" should show: (a) successive speeds at intervals of one mile per hour over the whole observed range; (b) for each speed, the number of times that it was observed; (c) for each speed, the cumulative number of times that it or a higher value was observed; and (d) for each speed, the "limiting percentage frequency", which is obtained by dividing the cumulative total by the number of observations. For example, Table 1 shows that SE or NW winds of 10mph were recorded at a certain "Station B" 18 times; that there were 157 occasions there when SE-NW winds were 10mph or over; and that their percentage frequency was (157/699) or 23%.

Secondly, the data (a) and (d) are applied to the construction of eight "Speed Analysis Charts" (figure 2). The speed in mph (a) is plotted against the percentage frequency (d) on graph paper. Then for each set of points a smooth curve is drawn through the highest points, so that none lie to the right of it. This is a so-called "enveloping curve", to which all plotted points will approach as the number of observations is increased.

Thirdly, the "Velocity Analysis Chart" (figure 3) is drawn. Each of the eight curves already prepared determines a series of points on this chart, *all along the ordinate corresponding to the particular wind direction*, and each a *limiting parameter for a standard speed*. For example, figure 2 yields the points (135°, 22%), (135°, 13%), (135°, 2%), and 135°, 1%) for the 10, 15, 20, and 25 mph curves respectively. Each curve of figure 3 has been drawn continuously through one of these points and its seven counterparts, one point from each "bi-directional" chart.

Finally, the analyst is ready to select the runway orientation which will have the highest percentage frequency of "safe" winds. In general, strong winds blowing at more than 20° against the

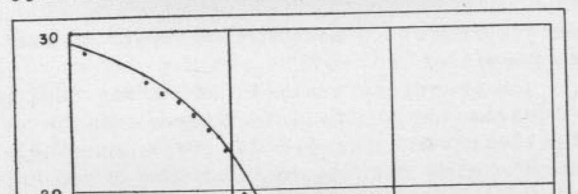


Figure 2: *"Speed* **Analysis Chart" of SE-NW winds at Station B---. This chart is one of eight drawn for each "bi-direction" in 16 points of the compass. Each chart is drawn from the data in a tabulation corresponding to Table I above.**

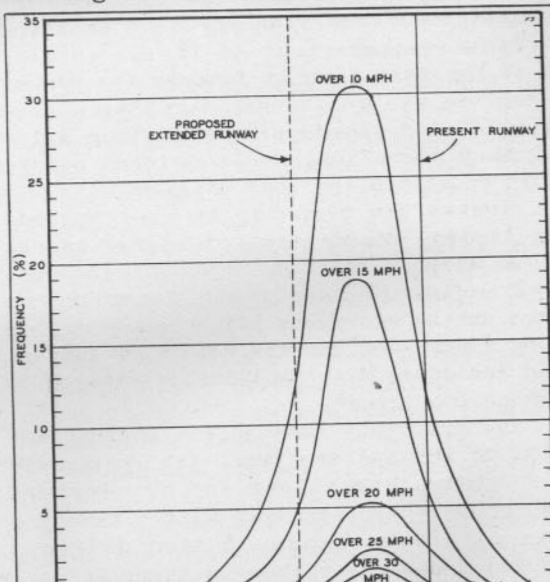


Figure 3: *"Velocity* **Analysis Chart" for Station B---. One is needed for each runway, drawn from the data on eight** *"Speed* **Analysis Charts."**

runway direction are dangerous, but when these same currents blow along the airstrip they are of advantage in assisting takeoff. The best runway orientation, then, from figure 3, is seen to be 120-300°.

Runway analysis for two actual, typical airports in the Near East are given below to clarify the modifications of the general procedure which are appropriate for specific problems.

RUNWAY ANALYSIS FOR STATION B---

The present runway is oriented at 144°-324°. There is also a short, unserviceable strip at 98°-278°. This report investigates the adequacy of the present runway, and evaluates the advantage to be gained by enlarging the short runway.

The file of Form 94 for Station B covers two years---a substantial period. Furthermore, its data are representative and reliable. The average wind speed at B--- is twice as great in summer as in winter. During the winter, the winds in the vicinity of the station usually are under the influence of the Arabian High Pressure Cell; but weak, occluded Mediterranean cyclones occasionally invade this region from the west. Neither winter type is characteristically accompanied by strong, sustained wind speeds. In summer, on the other hand, there is a steep low pressure area over Arabia. The wind direction at Station B is extremely steady from the Northwest (the Northwest Monsoon), and is strong enough to cause frequent duststorms. Figure 4 describes the far greater significance of summer winds in aircraft operations; and on that basis the runway analysis was confined to data for July, a typical summer month.

[Table I and figures 2 and 3, presented above to illustrate the general procedure, were originally prepared from the Form 94 data for Station B---.] Figure 3 shows a normal distribution of speeds, with 300-120° as an axis for lower velocities, shifting to 305-125° as the speeds increase. The present runway is within 20° of the direction of maximum frequency.

Figure 5 is constructed to test the value of enlarging the short runway. The difference in crosswind frequency between a one-runway (144-324°) field and a two runway (144-324° and 98-278°) field is used as a measure of the increased efficiency to be gained by lengthening the short runway. In this case the 10mph curve intersects the 22° crosswind angle at 32%. This may be interpreted to mean that for winds over 10mph having a cross-wind angle of less than 22 degrees, a two-runway field is 32% more efficient than a one-runway field. However, this increase in efficiency is negligible because the limits of the crosswind angle and the wind velocity are both non-critical. For more critical values the curves rapidly approach zero.

Certain very practical conclusions now can be drawn. The ideal runway would be 125-305°. The present runway, however, is close enough to be adequate. And most important, little would be gained by

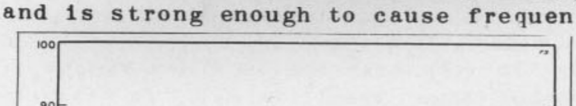


Figure 4: Describing the far-greater frequency of dangerous winds in summer at Station B---.

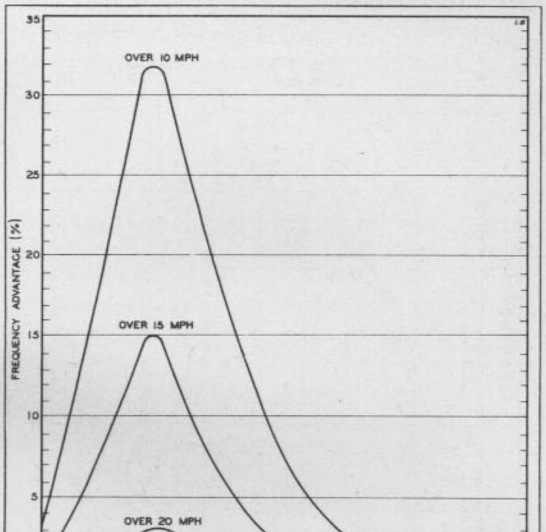


Figure 5: Evaluating the advantage of completing the short runway at B---. If the using aircraft are not affected by crosswinds of less than 20mph the ''frequency advantage'' is only a few percent.

extending the short (98-278°) airstrip.

Extension of the short runway had already been undertaken when the 19th Squadron was consulted; but as soon as the report above was presented, the construction was abandoned. The saving thereby accomplished was estimated to be $100,000.

ANALYSIS FOR STATION C---

A weather analysis for airport C--- is requested, to solve a threefold problem:
1) A single set of high-power, runway lighting facilities is available for installation on one of the three runways now in use at C---. On which airstrip should the equipment be placed so that it will be most useful?
2) Along which runway should a radio range beam be oriented so that it will permit instrument approach procedures to be made with a minimum danger from crosswinds?
3) Is there a need for the construction of a new runway?

An extensive file of Form 94 for C--- reveals that 76% of all instrument (or closed) weather occurs there between January and April, in the following proportion:

Fog and low stratus	2.5%
Haze and smoke	14.0%
Blowing sand or dust	83.5%

Only the last situation is associated with high winds. The tabulation of data in this case, therefore, is restricted properly to winds which produced blowing sand or dust between January and April. From the date eight envelope curves are prepared; and these, in turn, are used to construct figure 6. This "Velocity Analysis Chart"

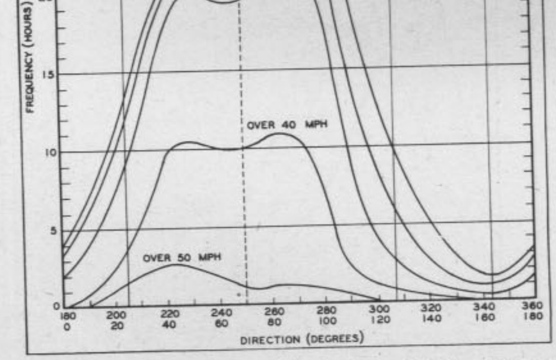


Figure 6: *"Velocity* Analysis Chart" for Station C---, drawn for bad-weather cases only. Not one extant runway is close to peak efficiency.

reveals that high winds in bad weather practically are confined to the quadrant between 210° and 300°.

It is apparent from figure 6 that a runway oriented at 70-250° would be best under the established conditions. However, to justify the expense of new construction, the three existing runways should be compared quantitatively with each other and with the ideal. To establish these relationships, figure 7 is drawn. The "efficiency" of a runway for any given crosswind component is defined here as the ratio of subcritical crosswind frequency to the total frequency of instrument (or closed) weather. Figure 7 reveals that if a crosswind of 20mph is considered to be critical for the using aircraft, then during instrument weather the 162-342° runway could be used safely only 32% of the time and the 24-240° runway only 50%. The ideal runway, however, under the same conditions could be used safely with respect to crosswinds on 80 instrument landings out of 100.

The practical conclusions to be drawn are these:
1) The runway in existence which is most useful for instrument landings is the 24-204° strip---50% to 70% efficient for aircraft with critical crosswind speeds from 20 to 30mph respectively.
2) The radio range station should be located to the east of the airport (at 24° if the best existing runway is considered adequate) so that instrument landings can be made upwind.
3) The construction of a new runway at 70-250° would result in a 30% increase in efficiency over the best of the present runways, and would be from 80 to 95% efficient if the critical crosswind were 20 to 30mph respectively.

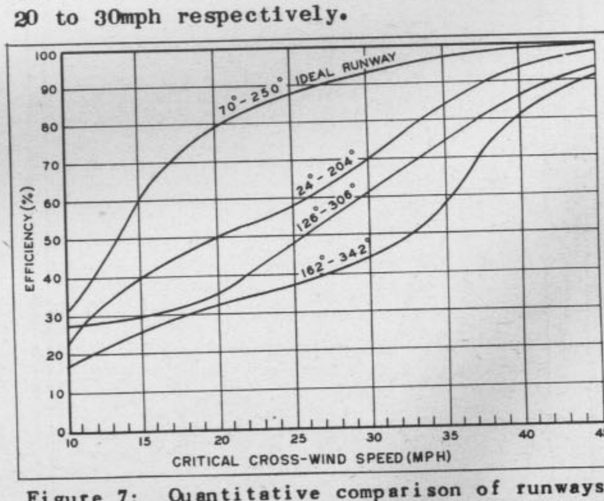


Figure 7: Quantitative comparison of runways. Decide upon the crosswind speed which is critical, and for that value as an ordinate read the efficiency of each runway off its curve.

PACIFIC PRESSURES

Captain M. P. LINK JR.
C-54 Project Officer

The oceanic expanses of the Pacific often were areas of dubious solutions on weather charts, even after Pacific skies became thick with Allied planes. Aircraft just were not equipped with the instruments required for really complete observations, nor did more than a few aircrewmen have experience at taking them. As a result, forecasts for the longest non-stop flights on schedule over water in the world---between California and the Hawaiian Islands---had to be drawn from weather reports which were entirely inadequate, particularly with respect to pressure and temperature at mandatory levels. Cries of "too little and too late" from combat units were related to these meteorological difficulties. In the absence of reliable wind forecasts, flyers had to be pessimistic about their time in flight (the fuel needed): C-54 pilots diminished their priceless payloads with a "better-safe-than-sorry" gasoline supply, and pilots of twin-engine tactical aircraft never felt sure that they would be able to reach Hawaii.

An electronic device finally was put to work on the shortage of upper-air data. Last winter the absolute (radio) altimeter was installed on twenty C-54 aircraft which maintained a regular schedule between California and the Marianas Islands (through Hawaii and the Marshalls). The use of this instrument in conjunction with the pressure altimeter and the thermometer reveals the pressure, the altimeter correction, the wind vector, and the temperature far from radiosonde stations; even more important, the absolute altimeter establishes the true height of whatever observations are taken. The new C-54 observations are broadcast immediately by aircraft radio to Oceanic Air Traffic Centers. As a result, the isopleths on Weather Service charts each day give a more definite and reliable description of the Pacific upper air. The average forecast error in ETA Hawaii has dropped below five percent: the payload of cargo aircraft and the safety of tactical aircraft correspondingly have reached higher values.

Absolute and pressure altimeters in co-operation on oceanic weather reconnaissance aircraft disclose the wind drift, the altimeter correction, and the pressure at flight level; and the absolute altimeter alone reveals the true height of these and other weather data. The enveloping presence of clouds is not a deterrent to altimetry observations. Giant C-54's now broadcast them on several flights a day from many points along the 7,000-mile Pacific Ocean route between the Philippine Islands and the United States. More and more C-54's are acquiring the necessary equipment and trained personnel to perform important meteorological services while on regular Pacific duty. Yet only nine months ago the Pacific Ocean was contributing great blank areas to 10,000-foot charts: the concentration of pressure and temperature data there was less than one percent of that available for the continental United States.

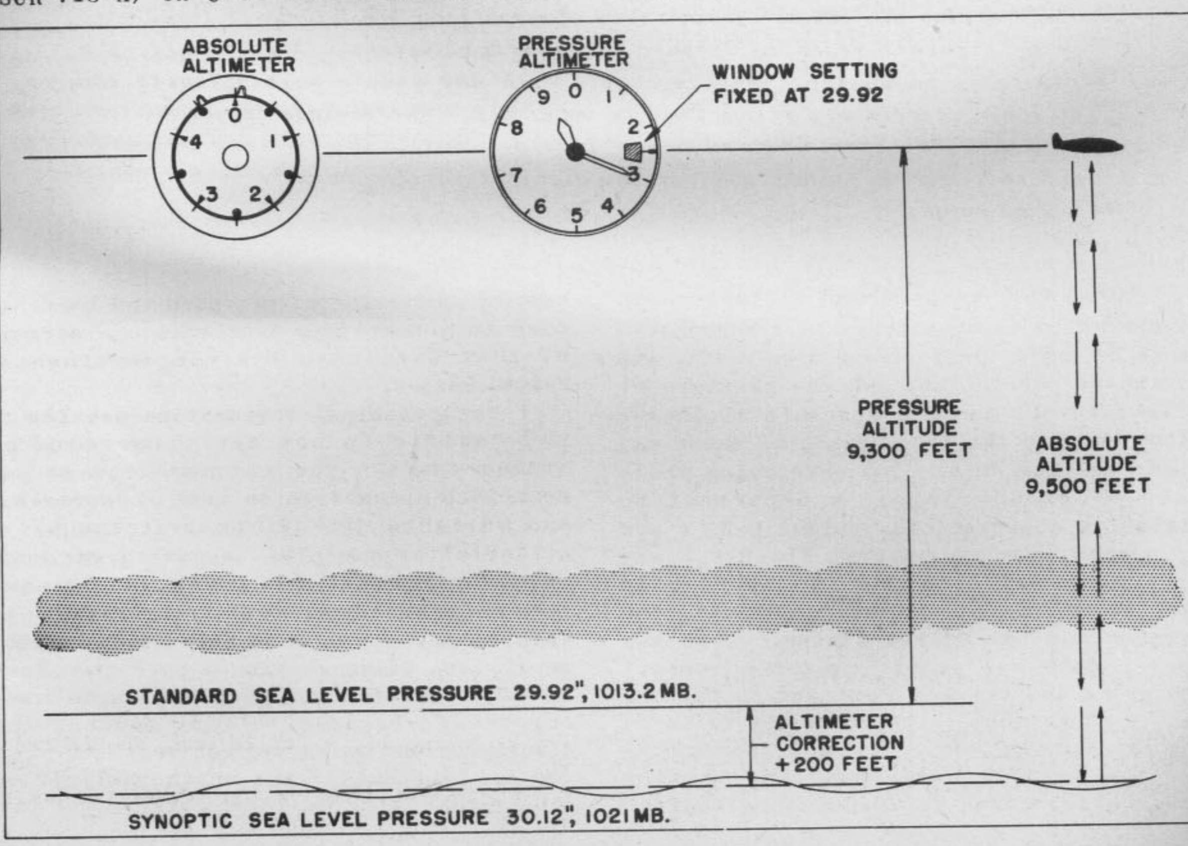
The principal forecasting problem in the Pacific is not the occurrence of hydrometeors. The weather between San Francisco and Saipan is much less violent and variable than it is over the North Atlantic for example. A persistent high cell dominates the route in summer, restricting significant cloudiness to stable, air-mass forms below 7,500 feet. In winter, although planes have been lost in the cyclones and fronts which move across mid-Pacific in that season, the cloudiness and icing are not very hazardous (38°N. latitude is the northern limit of the route).

Wind forecasting is the critical weather problem. Because the longest over-water flights in the world are scheduled regularly over the Pacific route, fuel there is an unusually large factor in the gross weight of an aircraft at takeoff. Effort to increase the payload properly begins with an attack upon the amount of gasoline carried---which in turn means that the duration of flight (the winds aloft) has to be anticipated well in advance. Wind forecasts are used also to select the safest days for dispatching twin-engine tactical aircraft to Hawaii, because that flight approximates the limit of their range.

Upper-air data were obtained before last winter from a few land-based Raobs and from the post-flight reporting forms filled out by *all* Pacific transport pilots as a matter of course. The Pireps perforce lacked pressure or height values, and were confined to a flight level which was neither known accurately nor convenient for forecasting purposes. The fact that aircrewmen might or might not be experienced in weather observation was even more difficult, because it presented the task of separating a mixture of accurate and inaccurate Pireps.

Installation of the absolute altimeter (SCR 718-A) on C-54's with weather-wise aircrews helped to relieve the difficult situation. Now their pressure altimeter setting is fixed at 29.92 inches, causing it to indicate the "pressure altitude" throughout each flight. At prescribed intervals, the observer reads the absolute and the pressure altimeters simultaneously. The difference between the readings is the "altimeter correction" for the flight level and position. It is this quantity which is radioed to shore from C-54 weather ships as their unique contribution, included as a supplement to the standard WAF-3 code report of temperature, pressure altitude, clouds, precip, position, and so on.

Weather station personnel convert these data to forms which are most effective in forecasting. They refer to a table of the standard atmosphere to determine the pressure at flight level directly from the altimeter correction value. Next, assuming that a standard lapse rate exists, forecasters compute from the reported temperature a mean temperature of the layer between flight level and 10,000 feet. Then they add the altimeter correction to the pressure altitude to find the absolute flight altitude. These three steps define all the variables necessary for solution of the Hydrostatic Equation to obtain the 10,000-foot pressure. And the 10,000-foot temperature obtained from the standard



lapse rate has been shown to be a satisfactory approximation.

Some stations, those which analyze the upper-air by the Bellamy techniques, find the C-54 reports particularly appropriate. These units require the value of the altimeter correction at a pressure altitude of 10,000 feet, which can be found from the data by the direct use of a nomogram.

Forecasters of weather in the tropical Pacific, where pressure gradients are flat and the geostrophic relationship goes awry, are not particularly interested in the pressures aloft. Their greatest use of the C-54 reports is to seek slight but consistent changes in altimeter correction, less than the equivalent of a millibar change in pressure, which might be valuable clues to the location of weak trough and ridge lines.

The weather reconnaissance aircrews are assisted by their own observations, particularly that of altimeter correction. Without further computation, an increase (or decrease) in the value of altimeter correction manifests passage into a barometric High (or Low). The rate of change of altimeter correction along the flight path measures that component of the wind which is perpendicular to the aircraft's heading. If time is available, a "double drift" procedure can discover the total wind vector. Approaches to mountainous shores or oceanic flight at very low levels in conditions of poor visibility, are rendered safer by reference to the absolute altimeter.

One shortcoming of the SCR 718-A is its blind spot at true altitude multiples of five thousand feet. This mechanical "bug" troubles pilots assigned to fly a pressure altitude of 9,500 feet (close to an absolute altitude of 10,000 feet under normal Pacific conditions). Flight Control cooperates by assigning aircraft equipped with absolute altimeters to some other altitude whenever possible.

The accuracy of pressures calculated from C-54 data is largely dependent upon the ability of the navigator to take accurate altimeter readings in flight. Some practice and reasonable care usually enable a navigator to report data which will yield pressure values correct to the nearest millibar. The indicated pressure *gradient* usually is precise even when the pressure values are incorrect, inasmuch as a given instrumental or observational error tends to be repeated. Reference to a reliable Raob enroute in these cases sometimes permits a forecaster to apply an empirical correction to the computed pressure values.

The whole process of calculating C-54 reports is a relatively simple one, but there are some pitfalls to be avoided. Early efforts to calculate pressures aloft were vitiated by a previous failure to calibrate the pressure altimeter. This oversight sometimes caused errors as great as six millibars. Now, a new pressure altimeter, recently calibrated in a laboratory test chamber and equipped with a calibration correction card, is installed along with each new absolute altimeter. The corrections for installational error in the pressure altimeter (varying with the type of static tube in use) are also posted nearby, to be applied along with the calibration correction.

Special weather-forecaster observers are used for C-54 reconnaissance over the North Atlantic, but not over the Pacific. The regular navigator can fulfill the weather duties: he has no aerograph or psychrometer to care for, and no detailed cross section to fill in; he is required only to prepare the regular WAF-3 weather report and its altimeter correction supplement. The excellent quality of the reports received so far confirms the wisdom of this policy.

Radio altimeters probably will be placed on *all* the C-54's which are now flying the Pacific ATC routes. Then the frequency of "complete" upper-air reports from cargo routes will exceed the wildest hopes which forecasters might have had a year ago. Yet while great improvements have been made, the oceanic coverage as a whole is still far from that which has been achieved on the North American continent.

It is difficult to evaluate exactly the contribution of the C-54 weather reconnaissance project to improved forecasting in the Pacific: the project is only one of several factors which have greatly improved the weather service in this area. Others have been a rising experience level of forecasters and an increasing emphasis on use of upper-air charts to supplement the surface map. As an indication of the degree of over-all improvement, the average error in forecast ETA Oahu has dropped from an average of 45.9 minutes in January 1944 to 29.9 minutes in January 1945.

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INDEX RESEARCH

REVIEW

"A Statistical Analysis of Certain Problems of Extended Weather Forecasting" has been published by M. I. T., comparing pressure patterns from the two winter half years of 1932-33 (low index) and 1935-36 (high index). Although statistical analysis is severely limited in its ability to give reasons or causes for the existence of any phenomenon, it is invaluable for determining just what *does* happen and in what sequence. In spite of the importance of certain conclusions in this paper for altering our concepts of the general circulation, its most significant contribution may be to outline the future research necessary for a full explanation of world flow patterns.

Rossby has demonstrated that changes in intensity of the zonal westerly circulation are accompanied by well-defined changes in pressure patterns on five day mean charts. In their application of this proposition, the Five Day Forecasting Unit of the Weather Bureau uses the "Zonal Index" (the average geostrophic wind between 35°N and 55°N, computed from the pressure difference between those latitudes). The Zonal Index and other indices were correlated with Rossby's relationships, a method for determining which one is associated most *uniformly* and *closely* with changes in the westerlies. Best results were obtained by considering a new index: the geostrophic average wind for that 20° zone of latitude which contains the greatest meridional pressure difference within the westerlies, wherever that zone may be found. This value is the "M-MZ.W Index", which seems to account for familiar fluctuations in latitude of the westerlies where the Zonal Index does not.

"If the zonal westerly circulation of middle latitudes is, as Rossby suggests, frictionally driven by the polar and subtropical direct circulation cells, then a *positive* lag correlation should exist between the polar easterlies and the middle latitude westerlies, insofar as the true strength of the complete polar and tropical cells is indicated by the surface easterlies." Yet when the polar easterlies were correlated with the zonal westerlies, the coefficients were generally *negative* in sign for both winters!

On the other hand, a marked positive lag relationship between the subtropical easterlies and the westerlies was obtained in every case for both winters. The highest degree of lag correlation between subtropical and middle latitude flow was reached after 4-5 weeks. Intriguingly enough, this is the same lag period as the one for which a tendency toward a slight positive relationship between the polar easterlies and the westerlies was noted.

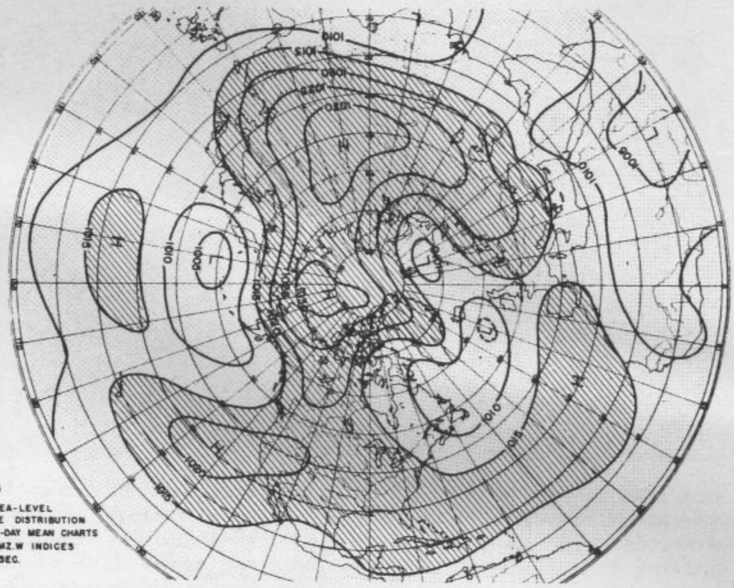
"The fact that all of the coefficients obtained by correlating the subtropical easterly indices with the zonal westerly indices were positive in sign indicates that the subtropical direct circulation cell may play a more important role in driving the westerlies than the polar cell. This seems quite logical since the subtropical cell receives its energy more directly than the polar cell, the latter being dependent in part upon the overriding of the moist air from the westerlies for its energy..."

Further results show that the relationship between the polar easterlies and the subtropical easterlies was almost entirely reversed from one winter to another. In correlation of the two indices (with the lag on the side of the subtropical index), all the coefficients but one were positive for 1932-33 and all for 1935-36 were negative. This is good indication that the general circulation must have functioned in a very different way the earlier winter from the way it functioned three years later.

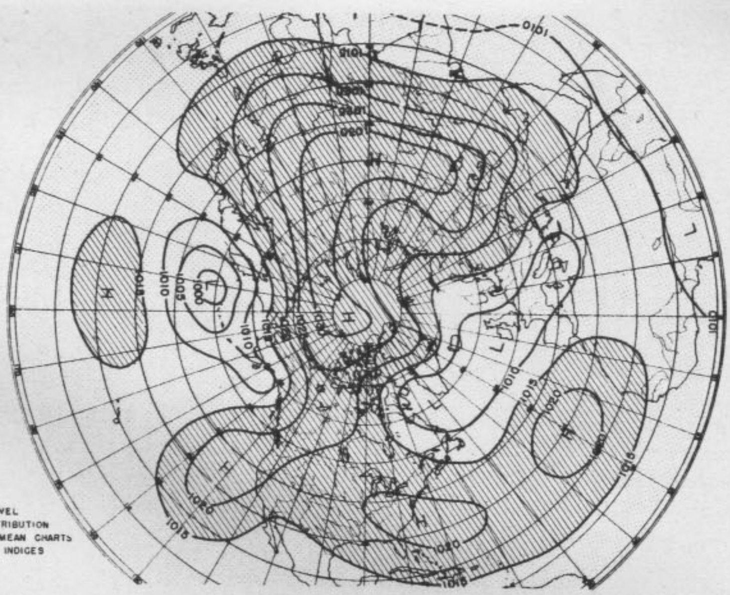
In 1932-33 strong outbreaks of polar air occurred which had enough momentum to break all the way through to low latitudes, thus completely upsetting the westerly circulation of middle latitudes and establishing a true low index situation at times. In 1935-36 however, the outbreaks of polar air were generally weak, tending to reinforce the westerlies rather than to destroy them. One might conclude that large contrasts in the circulation patterns and westerly strength would be noted in 1932-33, while in 1935-36 such contrasts would be smaller. This proved to be the case. In the 1932-33 winter there were eleven five-day periods which had an index of less than 1.00, while three years later there were only eight such periods in the same season. In 1932-33 there were 14 five day mean charts which had an index above 3.00, while in 1935-36 there were only four.

In another phase of investigation, one which had direct bearing on the validity of Five Day Mean forecasts, analysis revealed that pressure patterns are somewhat similar in their general characteristics upon all five-day mean charts which have about the same index value. The longitudinal location of the pressure centers seemed to vary considerably, however.

The M.I.T. authors recognize the limitations on their study put by the time extent of the data, but research is continuing to extend its scope. This review does not by any means contain the full value of the original report, and the complete study is valuable reading for interested forecasters. A copy is available at each Regional Control Office.



1932 - 33
MEAN SEA-LEVEL PRESSURE DISTRIBUTION OF ALL 5-DAY MEAN CHARTS WITH M-MZ.W INDICES < 1 M/SEC.



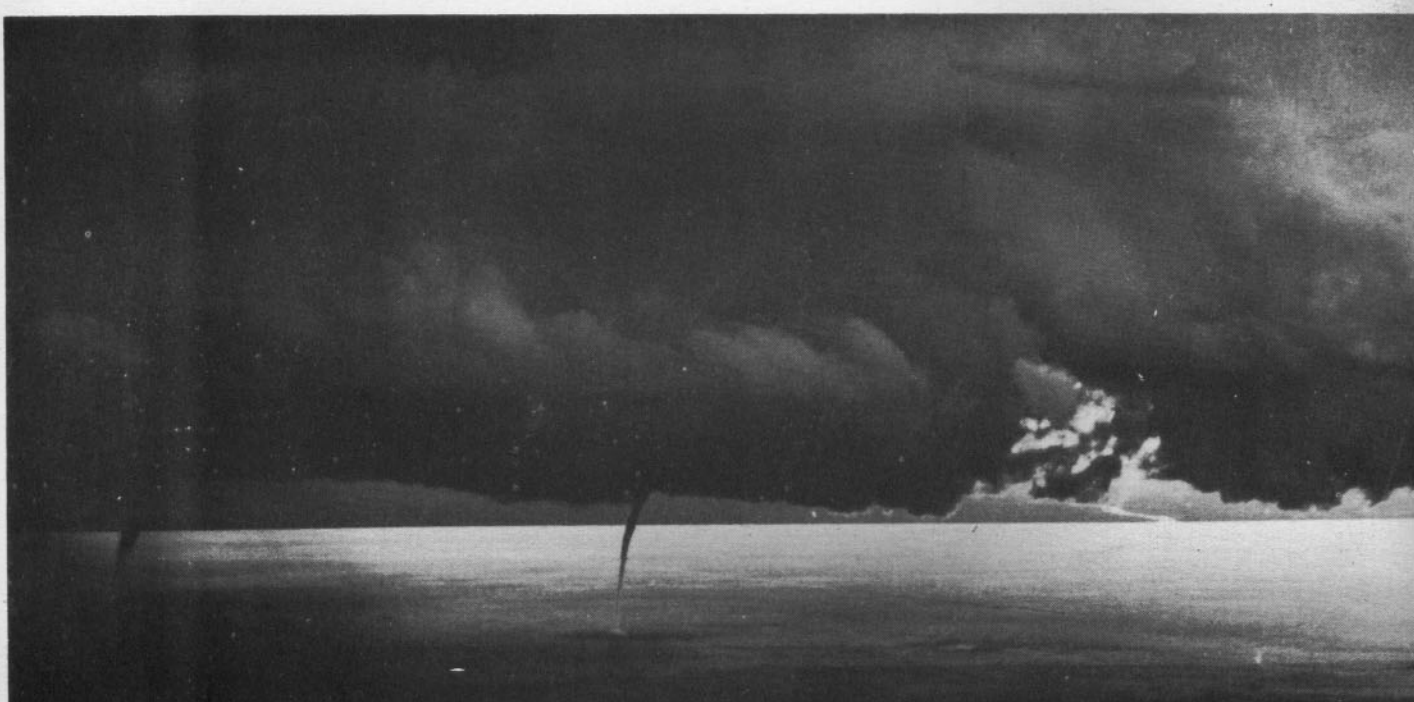
1935-36
MEAN SEA-LEVEL PRESSURE DISTRIBUTION OF ALL 5-DAY MEAN CHARTS WITH M-MZ.W INDICES < 1.00 M/SEC.

A theorem of five-day forecasting declares that all mean charts showing a particular index value will be alike in their large-scale features of pressure distribution. These charts test that principle. In 1932-33 the index was persistently low; in 1935-36 the index was persistently high. Nevertheless, the average charts for each year of all mean charts with index less than one meter/second are almost duplicates.

WATERSPOUTS IN

Major FRANCIS JOHNSON

These two waterspouts occurred beneath a great, nonfrontal *Cumulonimbus* over the Adriatic Sea, 25 miles offshore from Ancona, Italy. A reconnaissance meteorologist, Lt. R.W. Field Jr, was returning from a weather mission over Germany when he noticed the phenomena. Field descended to 4,000 feet, below a broken *Sc* deck just to the east, and took the first three photos within a few minutes, from a range of two miles. The date was 11 November 1944, and the time was 1330 GMT. Thunderstorms, showers, and convective clouds (2,000ft bases; 27,000ft tops) spotted the area. A sharp cold front had passed about 24 hours before, and the waterspouts were formed in the



coldest air mass of the season to that date. "They resembled milky columns," said the pilot. The sea surface was disturbed by three swirls, which must have been caused by vortices in the wind field. They appeared to be incipient waterspouts, but did not develop. Lightning and a shower were in progress (left of first photo). The pilot reported moderate turbulence under the *Cb* base, though he didn't fly into the *Cb* or across the line of vortices and columns. The fourth photo is a closeup taken from one-half mile to the east. The waterspout was 200 feet in diameter, with a sharp taper in its lowest 100 feet, ending in a needle point on the

THE ADRIATIC SEA

12th Weather Squadron

sea. This point largely was obscured by spray which rose from 35 square miles of agitated sea, whipped up to a height of at least ten feet. The waterspout was least dense near the surface: waves on the water beyond were visible through the lowest few hundred feet of the column. Its exterior was so smooth that only the centrifugal throwoff of cloud wisps gave evidence of rapid rotation. The southern waterspout dissipated after half an hour's observation. The top and the bottom of the column disappeared first and together: for two or three minutes a white cylinder, detached from both the sea surface and from the *Cb*, persisted.

FAST_ or SLOW?

Weathermen often sigh for more *time* or more *manpower*, asserting that "just a few more minutes" or "only one new man" would help produce observations, charts, and forecasts approaching perfection. But from the vantage point of headquarters, one can see that additional personnel are very scarce, and that the press of weather duties will not soon be relieved. The best solution seems to lie within each station. If a certain job regularly requires an abnormal outlay of time and manpower, the disturbing influences in certain cases might well be sought out and removed.

But few weathermen have known with any precision what the "time and manpower requirements" should be for specific jobs. They have had no comprehensive standard by which to judge the activity of their men. Now, however, the typical time requirement for various routine duties has been established by a careful investigation of certain domestic weather stations, taken in a broad sample. The values given in Table I were reported with a decisive unanimity by the stations tested.

A supplement to AAF Form 36, Weather Wing Form 36A, is being sent to domestic stations with new requests for manpower information. The data which are obtained from the completed Forms will be used in three ways: first, to reveal those stations which suffer from (or luxuriate in) a real manpower shortage (or surplus); second, to estimate the efficiency of individual station personnel by comparing their time requirements with the established Typical Times; and third, to modify slightly the Typical Times by averaging-in the new statements of time requirements.

If a weather unit should ever find it necessary to apply for additional personnel (or to justify its present strength), the existence of a reliable "manpower yardstick" would be of value. Some systematic criterion is needed even now to assure a just and appropriate distribution of manpower. It is absurd that there should be "haves and have-nots" among Weather Service installations.

The formula of page 15 has been developed as a manpower yardstick, and it has been confirmed as a reliable device by extensive tests. This formula avoids giving a false justification to those higher manpower "requirements" which are produced by lapses in efficiency, because it takes the Typical Times from Table I as constant from one station to another. For Items *a*, *m*, and *n* the value substituted in the formula varies only with the number of charts which are drawn regularly. The value of Item *b* depends only upon the number of services rendered. Other items do not vary significantly: for example, no request is made on Form 36A for the time spent in taking observations; not because that expenditure is overlooked, but because efficient observers just do not exceed the Typical Times. In summary, if the personnel of a station do not measure up to

TABLE I: "TYPICAL TIMES" FOR WEATHER DUTIES*
(Man-Hours per Day)

Standard Charts	*Plotting* (hrs) each	total	*Analysis* each	total
4 Synoptic Surface**	2.5	10.0	1.5	6.0
4 Winds Aloft	1.0	4.0	-	-
2 10,000 foot	1.25	2.5	0.5	1.0
1 13 kilometer	0.6	0.6	0.5	0.5
2 Surface Prognostic	-	-	0.5	1.0
1 10,000 ft Prognostic	-	-	0.5	0.5
20 Adiabats	0.08	1.6	-	-
15 Rossby's	0.08	1.2	-	-
Route Forecasts	-	-	0.5	1.5
1 Terminal Forecast	-	-	0.5	0.5
TOTAL		20.0		11.0

Additional Charts (per chart)	*Plotting* (hrs)	*Analysis*
5,000 foot	1.5	0.5
15,000 foot	1.0	0.5
30,000 foot	1.0	0.5
10 kilometer	0.75	0.4
16 kilometer	0.55	0.4
Isentropic	0.75	0.75
3-hourly Sectional	1.0	0.3
Hodograph	0.1	0.1
Cross-Section	0.5	0.3
Snow Cover	0.5	-
Cloud Cover	0.5	0.5
Raob Analysis (varies with detail attempted)		
Special Sectional (varies from 1 to 3 hours depending on extent of the chart)		

*The quantities given in Table I apply to constant-level analysis, which will be superseded in the U.S. by 1 July 1945. By then the *Weather Service Bulletin* will have presented a new table of "typical times", although it is believed that the values then will be similar to these.

**The typical time for synoptic map analysis is not meant to be a restriction upon the routine of a particular station. Unusual coverage and extraordinarily difficult problems may well require the expense of more than 1.5 hours for certain surface maps. Care, not speed, is the primary requisite in this case.

REQUIREMENTS OF A TYPICAL TYPE "A" STATION
(man hours per day)

Activity			
Forecasters' Activities			42.5 hrs
Analyzing charts and current weather:		*18 hrs*	
Analyzing standard charts	11 hrs		
Familiarization with current weather	4 hrs		
Additional charts required by the using agency	3 hrs		
Briefing pilots, preparing clearances and forecasts, telephone calls, and conferences:		*7 hrs*	
A dozen or more Forms #23 per day (10 minutes each), and a few Forms #23A per day (1 hr each	4 hrs		
Briefing	1 hr		
Informal personal and inter-office calls	2 hrs		
Miscellaneous Duties:			
Determining mean temperatures, spotting aircraft reports, verifying doubtful data, canned maps, etc.		*3 hrs*	
Training, administration, maintenance, and installation:		*11.5 hrs*	
Station management and administration	6 hrs		
Meteorological training	5 hrs		
Chart discussion (1 hr/week for 6 fcstrs)			
Short Range Verification (1.5 hr/wk/man)			
Refresher classes, study of recent developments, seminars, etc. (1.5 hrs)			
Maintenance and installation	0.5 hrs		
Military duties:		*3 hrs*	
Orientation, combat training, OD, guard, KP, etc.			
Observers' Activities			75.0 hrs
Taking regular observations:		*13 hrs*	
Making and transmitting 24 hourly observations @ 15 minutes each (sequence, inter-office, and delays)	6 hrs		
4 Pibals @ 1.5 hours.	6 hrs		
Special and check observations	1 hr		
Plotting charts:		*30 hrs*	
Standard charts	20 hrs		
Additional charts	6 hrs		
Aircraft reports; deciphering canned analyses; etc.	4 hrs		
Maintaining "service aids":		*16.5 hrs*	
Displaying sequences; ditto work; visual aids; etc.			
Administration and Maintenance:		*9.5 hrs*	
Administrative duties of the chief observer	6 hrs		
(Check forms, type letters, superintend observers, etc.)			
Maintenance duties	2 hrs		
(Installing new equipment; maintaining teletypes; minor instrument repairs; "keeping up" manuals)			
Training of observers (.75 hr/wk/man)	1.5 hrs		
Military duties:		*6.0 hrs*	
Inspections, cleaning weather station, KP, CQ, guard, etc.			
			117.5 hrs

117.5 hrs + 29.5 hrs (loading factor) = 147 man hrs/day. 147 ÷ 8 = 18.4 men

TYPE "B" STATION (man hours per day)

Forecasters' Activities		42.5 hrs
Observers' Activities		56.0 hrs
Plotting Charts	30.	
Maintaining "service aids"	16.5	
Administration	5.5	
Military duties	4.0	
		98.5 hrs

TYPE "D" STATION (man hours per day)

Taking regular observations	13 hrs
Administration and Maintenance	4 hrs
Military duties	5 hrs
	22 hrs

standard, they don't necessarily have a righteous claim for assistance.

A survey has disclosed that Items *c*, *d*, *o*, and *p* are relatively constant from station to station; therefore they have been treated as constants in the derivation of the manpower formula. It is a recognized fact that StaWO's and NCOIC's must work longer than eight hours a day to accomplish their administrative duties, and Item *d* does not include such "extra" (albeit necessary) activity. Item *o* may vary somewhat, but certainly the 16.5 man hours per day set aside for it are sufficient for the most exacting station routine. Form 36A does not require a report on the constant items because the manpower formula does not consider them as variables.

Weather stations must be prepared, by some means or other, to handle the pilot rush which occasionally overloads almost every forecasting staff. This problem seems to be ignored in Form 36A, which asks for the *average* time expended on briefings, clearances, forecasts, and telephone calls under Item *b*. It only appears to be ignored, however, because manpower computations with Form 36A data include a "loading factor" to provide for emergency requirements. This indirect procedure enables each StaWO to state his time requirements in simple terms; as an "average", rather than as some subjective quantity like a "mean maximum".

A work week of 56 hours (eight hours a day, seven days a week) for each man was postulated in deriving the manpower formula. The loading factor, which is included in the work week, accounts for the following contingencies over and above the man-hour requirements given in Tables II, III, and IV:

12% for Leaves, Furloughs, Illnesses, and Technical Schools

13% for Emergency Demands and Personnel Overhead (occasional overloads; meals, rotation of shifts, etc.)

For the purposes of an interesting manpower analysis, one might consider typical stations of the A, the B, and the D classifications. Typical Times, a typical extent of duties (analyzed fully in the tables on this and the preceeding page), the loading factor, and the 56 hour work week have been considered in deriving typical man hour needs:

TYPE A — 117.5 man hrs/day x 1.25 (l.f.) = 147 hrs or 18.4 men.

TYPE B — 98.5 man hrs/day x 1.25 (l.f.) = 123 hrs or 15.4 men.

TYPE D — 22 man hrs/day x 1.25 (l.f.) = 27.5 hrs or 3.5 men.

DAILY MANPOWER REQUIREMENTS FOR RADIOSONDE & RAWIN SECTIONS

	Rawins* (4 runs)	Raobs (2 runs)	2 Rawins Plus 2 Combined Runs	2 Combined Runs only
Visual and Performance Tests:	0.67**	0.33	0.67	0.33
Preflight Inspection and Baseline Check:	0.67**	0.33	0.67	0.33
Generation of Hydrogen:	3.00	1.50	3.00	1.50
Calibration and Maintenance of Equipment:	2.00	0.17	2.17	2.17
Forms (Maintenance, Weather, and Status):	4.00	0.30	4.30	2.30
Service on Motor, Heater, and Generator:***	1.00	0.30	1.00	0.65
Balloon Treatment, Inflation, Assembly:	2.00	1.00	2.00	1.00
Warming & Tuning (Preflight adjustment):	2.00		2.00	1.00
Tracking Balloon:	6.00		6.00	3.00
Plotting, Computing, & Coding (with time for necessary reflights):	8.00	10.00	18.00	14.00
Administrative and Military Duties:	2.50	1.50	4.00	2.50
Research, Study, etc.:	2.50	1.50	4.00	2.50
TOTAL	34.34	16.93	47.81	31.28
25% Loading Factor	08.57	04.24	11.95	07.82
TOTAL	42.91	21.17	59.76	39.10
Required Manpower	5.4	2.6	7.5	4.9

*When Rawins are taken by Radar equipment, storm detection service may also be required, estimated at 6 man-hours per day.

**Will be reduced in the near future.

***Less in every case where line power is available.

MANPOWER Yardstick

EQUATION FOR DETERMINING THE NECESSARY PERSONNEL AT AN ARMY WEATHER STATION

$$^{*}\text{TOTAL MEN PER STATION} = 6.6\,\frac{(a+b+c+d+e)}{42.5} + 11.8\,\frac{(m+n+o+p+q)}{75}$$

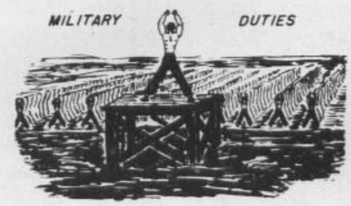
FORECASTERS' ACTIVITIES

(MAN HRS/DAY)

ANALYZING CHARTS & CURRENT WEATHER

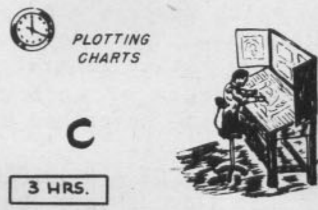
a [ ]

MILITARY DUTIES



e [ ]

PLOTTING CHARTS



c [3 HRS.]

BRIEFING PILOTS, PREPARING CLEARANCES AND FORECASTS, TELEPHONE CALLS AND CONFERENCES.

b [ ]

METEOROLOGICAL TRAINING, ADMINISTRATION, MAINTENANCE AND INSTALLATION DUTIES.

d [11.5 HRS.]

+

OBSERVERS' ACTIVITIES

(MAN HRS/DAY)

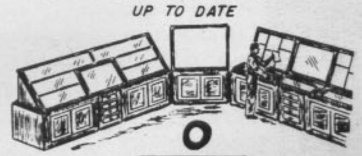
MAKING AND TRANSMITTING OBSERVATIONS.

m [ ]

MILITARY DUTIES

q [ ]

DISPLAYING SEQUENCES, DITTO WORK, KEEPING SPECIAL DISPLAY DEVICES UP TO DATE



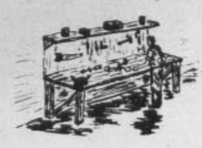
o [16.5 HRS.]

PLOTTING CHARTS

n [ ]

ADMINISTRATIVE & MAINTENANCE DUTIES

p [9.5 HRS.]



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TOTAL ACTIVITY FOR CLASS "A" STATION

$$^{*}\text{TOTAL MEN REQUIRED} = 6.3 + .15\,(a+b+e+m+n+q)$$

* UPPER EQUATION SIMPLIFIES TO LOWER ONE WHEN VALUES OF CONSTANTS C, D, O & P ARE INTRODUCED.

Headquarters Notes

Regional Air Inspectors each month send a report to Headquarters Weather Wing of the irregularities and discrepancies which they have noted during field inspections of weather stations. Hereafter, each issue of the *Weather Service Bulletin* will present a monthly resume of their findings, with a view toward assisting StaWO's and NCOIC's to prepare for the next inspection. Obviously, the most-frequently-reported irregularities and deficiencies are the matters which deserve a priority in their preparations. The items of the resume perforce are rather general, but with the first appearance of each category in a report it will be described by examples.

MONTHLY REVIEW OF AIR INSPECTORS' REPORTS
(for January 1945)

Average Rating	TOTALS Excellent No.	%
Reports Received	64	100
Filing System Inadequate	28	43.7
Improper Care and Maintenance of Instruments	22	34.5
Inadequate Security Precautions	20	31
Improper Management of Station	18	28
No Deficiencies	15	22
Maps and Charts Improperly Plotted	12	18.6
No Irregularities	10	15
Maps and Charts Improperly Analyzed	8	12.5
Training (Soldier's) Not Complete	6	1

Definition of Generalized Categories
(by examples)

Average Rating:
A summation of the ratings given the various weather stations by the regional Air Inspectors.
Reports Received:
The total number of inspection reports received at this headquarters from the various weather regions. This figure should not be construed as an indication of the inspections that were made during the particular period, because reports are often delayed.
No Deficiencies:
No Irregularities:
The statement "No Deficiencies" or the statement "No Irregularities" was contained in the inspection report.
File System Inadequate:
All publications required by pertinent RCO directives not on file, actual filing system used disorganized and/or inadequate, file of RCO publications and/or Weather Wing publications inadequately maintained, etc.
Improper Care and Maintenance of Instruments:
Wind support and associated instruments unpainted, theodolite improperly mounted and/or wired, directives concerning care and operation of hydrogen generators not complied with, etc.
Inadequate Security Precautions:
Some personnel not cleared for cryptographic duties, security check not made, codes and ciphers not properly stored, etc.
Improper Management of Station:
Items that are the responsibility of the Station Weather Officer or a Non-Commissioned Officer In Charge: inadequate work schedules, improper supervision of operation of weather station, lack of coordination with base personnel, etc.
Maps and Charts Not Properly Plotted:
Rawin data not plotted in accordance with Weather Wing Memorandum 95-4, all available reports not plotted on map, synoptic reports not plotted in compliance with existing directives, etc.
Maps and Charts Improperly Analyzed:
Non-compliance with Weather Wing Memorandum 95-6, past and future positions of fronts and pressure centers not properly indicated, inadequate compliance with Weather Wing Memorandum 95-7, etc.
Training (Soldier's) Not Complete:
Basic training not completed, qualification in prescribed arms not complete, inadequate compliance with directives pertaining to physical examinations and/or immunization, etc.

JOBS NOW IN METRO

The leaders of various business enterprises gathered at the University of Chicago some weeks ago by invitation of the American Meteorological Society and the University. Before them was placed a proposal to survey certain industries and commercial pursuits, with a view toward establishing objectively the influence of weather and climate on their operations. Dr. C-G. Rossby reports that "considerable interest" was evidenced.

The AMS president later asserted in a letter to this headquarters: "Such surveys are indispensable prerequisites to a healthy growth of industrial meteorology, but (they) may have to be delayed until after the war unless qualified personnel for such projects can be made available now.

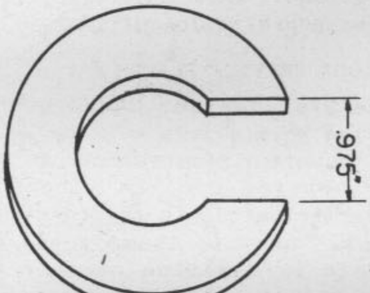
For this reason it is requested that competent (ex) military meteorologists who have been discharged for medical reasons get in touch with the AMS Office in Chicago, particularly those with pre-war business or engineering experience. Possible employment in such survey projects as they develop (awaits men with these qualifications)."

Metro Musings

RAOB THRIFT, II

A premature notice to "Change Now!" appears on each roll of radiosonde recorder paper when 30-40 feet of usable paper still remains. Radiosonde men at Chanute Field (Illinois), feeling that they were being played for suckers by this notice, devised a gadget which would indicate the correct time to change the recorder paper roll.

The gadget, pictured below, is made



from an aluminum washer. Its 0.975 inch opening is the critical diameter for recorder paper reserve: when the washer will slip over the roll, then it is time for a change. Care is taken to use washer metal thick enough to make sure that the gadget is perpendicular to the roll's axis during each test.

HOAR FROST

The early-morning calm of a French countryside was rent by a roar of motors one day last January as pilots of the ---Bomb Group readied their A-26's for a ground-support mission. The first two aircraft in succession moved sluggishly down the full length of the runway, finally becoming airborne. The third followed until it left the ground; then it settled back sickeningly and exploded against the end of the runway. Two more attack bombers were takeoff crash victims in the same operation within the next 15 minutes.

Later, each of the surviving pilots agreed that their planes had felt heavy and extremely sluggish from the first. Accumulation of hoar frost upon wings and propellers was decided to have been the cause of the accidents. None of the pilots had reported frosty airfoils to Operations prior to takeoff; mainly, they said afterwards, because frost had covered the windshields! Engineers asserted that 1 to 2½ hours before takeoff, "Kill Frost" had been applied to all of the planes. Apparently, an extraordinary amount of hoar frost had been deposited in a short time. And just as apparently, the pilots had given no thought to the dangerous nature of hoar frost.

A situation for which one might forecast the danger of hoar frost occurs when the wing surface temperature is less than the dew point observation and it, in turn, is less than the freezing point. In the case of the A-26 icing, patchy fog, dewpoint 21°F, and temperature 21°F had prevailed. The rate of frost deposit is proportional to the difference between the dewpoint and the wing-surface temperature. Although the reasons for condensation of hoar frost on various surfaces is still understood imperfectly, a forecasting approach to the problem is given in *Weather Division Report #897*.

IQ AND RANK

Is there any relationship between a weatherman's rank and the score he made on the Army General Classification Test? The *12th Wx Poop Sheet* for March, 1945, contains the results of some statistical research on this question. Relative standings for 12th Squadron personnel turned out to be:

1. Lieutenants
2. Privates
3. Warrant Officers
4. Master Sergeants
5. Technical Sergeants
6. Privates First Class
7. Staff Sergeants
8. Corporals
9. Sergeants

DEWPOINT FRONT

Unseasonal thunderstorm activity in the New Mexico and west Texas area recently has revived interest in the so-called "dewpoint front." Its surface location and its frontal slope proved to be important considerations in forecasting areas of thunderstorm activity there. Some weather schools have taught forecasters to avoid drawing for the dewpoint front, but the weather that has occurred so far in 1945 and the evidence set forth during the consultant team meetings have dispelled doubts among Third Region forecasters about its reality. Consideration of the dewpoint front is of extreme value in forecasting for Texas and New Mexico.

---from the *History, Third Weather Squadron* (Sheppard Field, Texas, contribution)

APOBS HELP STRATUS FORECASTS

The Dalhart AAF weather station experimented successfully with APOBS this February in their search for aids to stratus forecasting. Observations were taken for temperatures aloft at every *500 feet* from the surface to 10,000 feet MSL. Temperatures were taken with an ordinary dry-bulb thermometer from a liaison-type airplane (L-5). Since the airspeed of the L-5 ranges from 80 to 100 mph, a negative one-degree-centigrade correction was used on all readings. Indicated altitudes were corrected to true altitudes, and then converted to millibars of pressure in the standard atmosphere by the use of the Bellamy Slide Rule. The use of these airplane soundings at times when the synoptic situation showed the possibility of stratus formation was found to increase greatly the accuracy of the forecast of time and height of stratus formation, of the minimum ceiling, and of the time of dissipation. It was also found upon occasion that where the synoptic situation indicated a very good possibility of stratus formation, and would ordinarily require forecast of stratus in the morning, the APOBS taken at 1600 LST would show stratus formation to be practically impossible. Many embarrassing moments were avoided in this way. At present it is believed that these soundings need be taken only at times when the synoptic situation shows the possibility of stratus. Later it may be decided to take them daily at 0800 and 1600 to determine whether they will be of additional use in forecasting thunderstorms and other weather phenomena at this station.

---from the *History, Third Weather Squadron* (Dalhart AAF, Texas, contribution)

V-IN-E

The changing scenes of war will bring new problems to the Weather Service, some of which are apt to place weathermen in unenviable positions. The latest historical report of a squadron which is enduring the throes of redeployment points out one phase of the problem:

During recent months, many stations in the ___ Region have submitted requisitions for additional personnel, which the RCO has been unable to fill because his Squadron was already utilizing all of its authorized strength. As AAF personnel of most classifications except weather were transferred to new theaters, many administrative responsibilities were placed upon weathermen as additional duty.

Some situations were extreme. The station weather officer at one "ghost" base found himself acting as CO during the temporary absences of the Commanding Officer. Regularly the harrassed StaWO was also Base Theater Officer, Base Technical Inspector, and Base Claims Officer. The assistant StaWO fared no better. He became Raob-Rawin Officer, Base Finance Officer, and custodian of the Officers' Mess Fund. Three observers found themselves running the base coffee shop, and an enlisted forecaster became theater projector operator.

Conditions were just as bad at a nearby weather station, where the StaWO was also Assistant Operations, Post Exchange, Base Photo, Range, and Recreation Officer! Two other forecasters shared the jobs of Provost Marshal, Special Service, Billeting, and Graves Registration Officer.

MERITORIOUS SERVICE PLAQUE

The 21st Weather Squadron has been awarded the Meritorious Service Unit Plaque for its "superior performance" in providing weather service for the Air and Ground Forces participating in the invasion of the Continent. As this issue goes to press, incomplete information reveals that the 12th and 13th Weather Squadrons have also received this award. The Meritorious Unit Service citation of the 21st Squadron, the first of its kind to go to a weather unit, commends the 21st especially for:

Developing and equipping stations which were able to be moved long distances and put swiftly into operation;

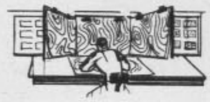
Cooperating with the British Admiralty and the Chief Engineer of the Armies to provide invaluable oceanographic information that aided in determining the best time and place for landing operations and for unloading supplies;

Organizing and training a weather reconnaissance squadron which provided service to the Tactical Air Commands and the Bombardment Division of the Ninth Air Force;

Developing a meteorological ballistics program which was used by Anti-Aircraft and Field Artillery units; and

Training the Radar crews of artillery battalions in Radar weather duties.

SHORT RANGE VERIFICATION



RELATIVE STANDING OF DOMESTIC FIELD FORECASTERS
Weeks 1-68; 4 October 1943 to 24 January 1945

THE 100 LEADING FORECASTERS (2,500 participants)

National Ranking	Name	Rank	Region	Station	"R" Value	"S" Score	Regional Ranking
1	Jordan, H. J.	MSg	4	Smyrna AF	95	438	1
2	Melhorn, W. N.	2Lt	4	Bluethenthal	95	439	2
3	Auslander, H.	SSg	23	Offutt FD	92	541	1
4	Katz, Y. H.	MSg	1	Stockton FD	93	630	1
5	Clarke, R. F.	TSg	23	Kansas City	94	633	2
6	Hoffman, R. E.	1Lt	4	Jacksonvl AF	92	634	3
7	Whiteley, Jr., G.	Cpt	1	Luke FD	71	646	2
8	Hirschfeld, W. P.	TSg	25	Ft. Dix AB	94	658	1
9	Brumbach, J. J.	2Lt	25	Phillips FD	87	661	2
10	Law, Jr., E. A.	2Lt	2	Patterson FD	84	695	1
11	Moir, J. F.	2Lt	4	Avon Park AF	83	702	4
12	Taft, H. E.	1Lt	3	Tulsa	92	706	1
13	Posey, J. W.	SSg	23	McCook AF	80	707	3
14	Harris, E. W.	SSg	4	Florence AF	88	714	5
15	Peterson, B. J.	TSg	24	Ellensburg AF	92	721	1
16	Kautz, E. D.	MSg	1	Salinas AB	93	727	3
17	Brouns, R. C.	2Lt	2	Fargo AP	82	732	2
18	Gans, W. L.	SSg	25	Olmsted FD	91	733	3
19	Koss, H. D.	TSg	2	George FD	92	735	3
20	Ace, E. R.	2Lt	1	Coolidge AF	89	737	4
21	Lutz, G. H.	2Lt	4	Brookley FD	87	743	6
22	Goldman, J. G.	TSg	4	Birmingham AF	94	745	7
23	Lenon, D. R.	2Lt	23	Rapid City AB	87	7[illegible]7	4
24	Criscillis, P. A.	2Lt	4	Asheville WX WG	94	757	8
25	Wetzel, W. E.	2Lt	25	Bolling FD	92	759	4
26	Heinrichs, G. A.	SSg	2	Rochester	83	761	4
27	Reed, C. K.	1Lt	23	Rosecrans FD	94	762	5
28	Moraski, J. J.	MSg	25	Pittsburgh AP	91	768	5
29	Hoffman, C. E.	Cpt	2	Chanute FD	94	771	5
29	Bluhm, W. C.	SSg	25	Pittsburgh AP	91	771	6
31	Holladay, C. B.	2Lt	3	De Ridder AB	91	778	2
31	Smith, H. F.	2Lt	4	Venice AF	87	778	9
33	Johnson, P. A.	1Lt	1	Los Angeles	92	779	5
33	Gleason, J. M.	2Lt	4	Chatham AF	88	779	10
35	Tomchek, E. J.	MSg	4	Maxwell FD	95	781	11
35	Lee, G. M.	MSg	24	McChord FD	93	781	2
37	Heggie, G. D.	1Lt	23	Des Moines	94	782	6
38	Grasso, C. H.	2Lt	4	Asheville	91	784	12
39	Anderson, E. E.	2Lt	4	Asheville WX WG	91	785	13
40	Kleyensteuber, C. J.	TSg	1	Coolidge AF	95	786	6
41	Werner, W. L.	2Lt	23	Lincoln	83	787	7
42	Worthman, P. E.	Cpt	4	Asheville WX WG	94	788	14
43	Pipp, W. B.	2Lt	23	Peterson FD	83	789	8
44	Jones, M. V.	MSg	4	Maxwell FD	93	794	15
44	Sheperd, K. R.	2Lt	4	Venice AF	89	794	15
46	Henry, A. J.	TSg	25	Pittsburgh AP	90	795	7
47	Webb, F. E.	1Lt	4	Chatham AF	94	796	17
48	Jess, E. O.	Cpt	4	Seymr Johnson	95	797	18
49	Laseur, N. E.	SSg	23	Sherman FD	93	798	9
50	Koller, C. R.	2Lt	4	Sarasota AF	91	799	19

50	Onsager, G. G.	TSg	24	Redmond AF	93	799	3
52	Davison, W. R.	SSg	23	Malden AF	93	801	10
53	Welch, Jr., A. E.	MSg	4	Memphis AP	96	807	20
54	Morris, J. C.	2Lt	4	Asheville WX WG	90	809	21
54	Vanderzee, C. E.	1Lt	23	Kansas City	94	809	11
56	Kaminski, H. S.	TSg	4	Drew FD	94	810	22
56	Aichele, W. J.	2Lt	25	Pittsburgh AP	92	810	8
58	Williamson, G. A.	1Lt	4	Maxwell FD	95	811	23
59	Strum, A.	TSg	1	Mather FD	90	812	7
59	Musa, R. C.	2Lt	4	CP Davis AF	89	812	24
61	Murphy, E. E.	SSg	3	Muskogee AF	93	813	3
61	Allers, H. D.	TSg	4	Asheville WX WG	91	813	25
61	Olsen, J. W.	1Lt	4	MacDill FD	80	813	25
61	Begg, E. L.	SSg	23	Lowry FD	91	813	12
65	Lawless, K. R.	2Lt	4	Morris FD	94	814	27
66	Simpson, D. L.	2Lt	4	Asheville	93	816	28
67	McCrabb, H. S.	1Lt	3	Perrin FD	94	817	4
68	Elder, K. C.	CWO	2	Scott FD	80	820	6
68	McCarthy, W. J.	Cpt	2	Patterson FD	89	820	6
68	Wooldridge, G. L.	2Lt	3	Enid AF	88	820	5
71	Cable, D. A.	TSg	4	Sarasota AF	92	821	29
71	Wagner, I.	TSg	4	Wm Northrn FD	92	821	29
73	Branche, J. B.	1Lt	4	Tuskegee AF	94	824	31
73	Salon, L.	1Lt	25	Syracuse	86	824	9
75	Keller, W. J.	Sgt	4	Maxwell FD	87	825	32
76	Blumenthal, J. H.	2Lt	4	Tyndall FD	80	826	33
76	Garrison, Jr., J. B.	2Lt	4	Memphis AP	90	826	33
76	King, T. L.	2Lt	25	Pittsburgh AP	88	826	10
79	Harms, R. W.	1Lt	4	Courtland AF	94	827	35
79	Meyerson, A.	TSg	23	Denver	93	827	13
81	Culbertson, H. M.	2Lt	1	March FD	94	828	8
81	Dorsch, R. G.	2Lt	2	Patterson FD	82	828	8
81	Horn, L. H.	Sgt	2	Chanute FD	68	828	8
84	Hronek, R. M.	1Lt	3	Perrin FD	93	829	6
84	Erwin, E. A.	2Lt	23	Walker AF	88	829	14
86	Gillespie, L. V.	Maj	1	Long Beach	94	830	9
86	Kimmel, M. M.	1Lt	4	Marianna AF	94	830	36
86	Josephson, E.	SSg	23	Peterson FD	91	830	15
89	Rivers, N. E.	2Lt	2	Patterson FD	48	833	10
89	Moore, W. G.	1Lt	3	Carlsbad AF	94	833	7
89	Jackson, J. E.	2Lt	4	Winston Salem	90	833	37
89	Solomon, M. L.	SSg	24	Portland AB	92	833	4
93	Dale, A. C.	2Lt	4	Nashville AP	92	834	38
94	Sherman, W. G.	2Lt	4	Courtland AF	90	835	39
94	Ruzicka, R. R.	SSg	25	Boston AP	89	835	11
96	Heinmiller, C. S.	2Lt	3	Hondo AF	88	836	8
97	Martinson, G. W.	2Lt	4	Greenwood AF	90	837	40
97	Toyli, M.	MSg	4	Jacksonvl AF	92	837	40
99	Dalrymple, H. R.	TSg	1	Douglas AF	93	838	10
99	Carlisle, J. G.	2Lt	4	CP Davis AF	89	838	42
99	Herman, P. B.	2Lt	4	Buckingham AF	87	838	42

RESULTS BY REGIONS

Regions	Forecasters Participating	Distribution of Grades (%) A	B	C	D	E
Fourth	540	17	34	36	9	4
Second	232	10	34	40	12	4
All	2417	10	30	40	15	5
Twenty-third	345	12	29	37	17	5
Twenty-fifth	229	11	25	42	17	5
Twenty-fourth	155	7	30	46	10	7
First	347	6	32	44	15	3
Twenty-sixth	40	8	22	48	20	2
Third	529	6	26	41	20	7

CONTENTS

page

(R) means Restricted

FRONT COVER PHOTO . . . . from: History, 16th Weather Squadron

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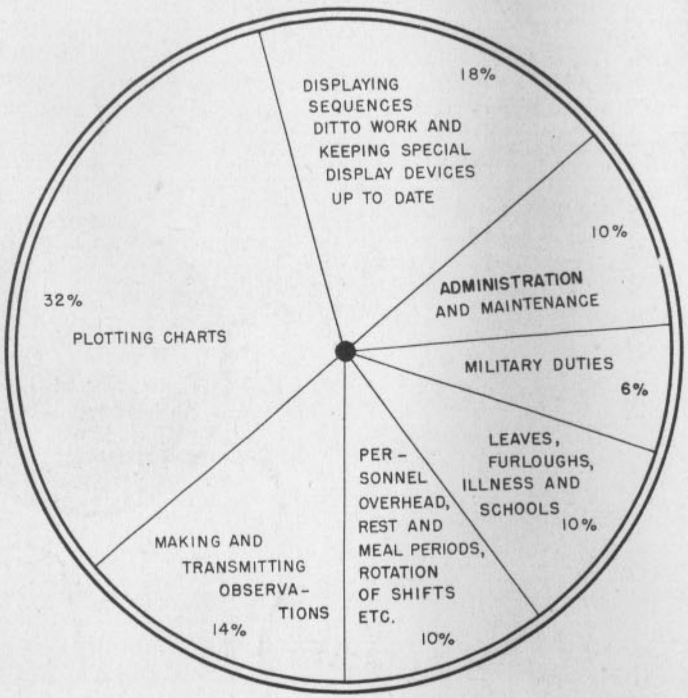
EXPENDITURE OF TIME IN A TYPICAL WEATHER STATION

CLASS "A"- FORECASTING AND OBSERVING

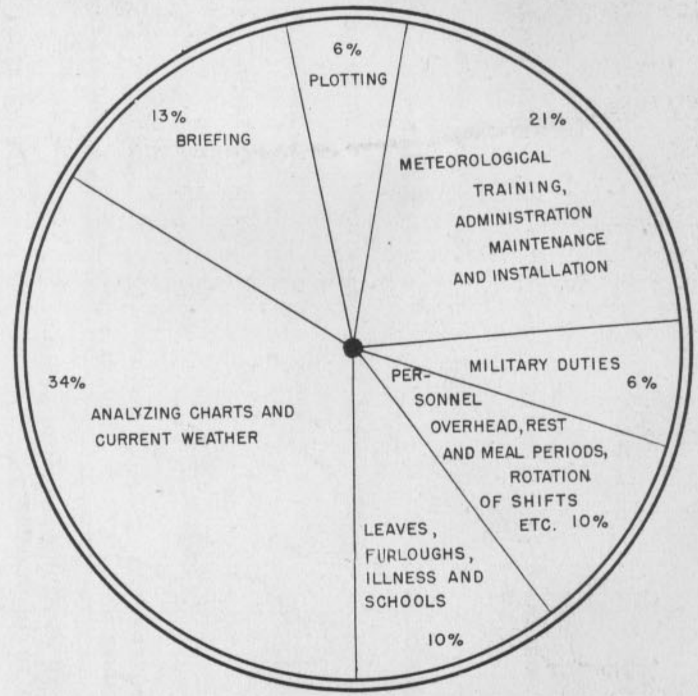
A large, representative sample of domestic AAF weather stations have reported their disposition of manpower among routine duties. From that information, a table of "Typical Times" has been drawn up (page 12) as a criterion for efficiency in various weather jobs. The manpower "pies" below show how weathermen in the U.S. spend their working day.

OBSERVERS



A working day of eight hours (56 hours a week), including military services rendered to the base, has been postulated for AAF weathermen in the U.S. Since the typical "A" station requires 94 man hours of observer activity every day, the manpower need in this specialty is 94 ÷ 8 = 11.7 men.

FORECASTERS



The same work week of 56 hours has been set for forecasters, to be applied to the requirements of "A" station routine, 53 man hours per day. The requisite number of forecasters, therefore, is 53 ÷ 8 = 6.7 men. The classifications of duty are explained on page 13 of this issue.