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substantial modifications of existing DME equipment. Thus, severe operational and economic problems stand in the way of implementation of expanded VOR/DME channels. However, the implementation of airborne off-set course capability in the form of pictorial displays, off-set computers, or other devices will limit the requirements for new VOR/DME facilities and will increase the operational utility of the aircraft.

The most obvious omissions from this list are ILS, marker and ADF receivers. The utility and functional value of these are recognized. However, they are not considered to be elements of the basic air navigation and traffic control system because of the following considerations:

- a. ILS facilities are currently provided only at major terminals, the number of which is less than 3% of the total number of FAA-registered airports. It is not envisioned that this percentage will change substantially in the future. In addition, aircraft not equipped with ILS receivers can make IFR approaches to both ILS-equipped and non-ILS-equipped airports through the use of other navigation aids. Consequently, although ILS will continue as an element of the common system, the carriage of airborne receivers for the use of ILS falls within the category of "user's option."
- b. Marker facilities are currently provided as a position-fixing service. However, alternate means are available and are in general usage. The need for markers is expected to decrease in the future, particularly as DME services are expanded. Accordingly, airborne marker receivers are not considered "required" equipment.
- c. At this time, ADF is extremely useful and necessary equipment in certain airspace. It will undoubtedly have continued utility, but its use as a basic navigation device is expected to decline in the future. For this reason, it is not included in the "required" category.

The choice of just what communications and navigation equipment should be installed in an aircraft has always been a difficult one. It is even more difficult today in light of the unsettled condition of Government planning. There is an inevitable tug-of-war between the kind of equipment and service the aircraft owner might like to receive, and the hard facts of cost plus power, weight and space factors imposed by the physical capabilities of the aircraft. The final choice is dependent upon these factors, viewed in the light of the utility and operational use expected of the aircraft by the owner. Careful planning for the future is a "must" in considering airborne electronic equipment purchases. END

# The Weather And

*EDITOR'S NOTE: In the January issue of The PILOT, Frank A. Tinker's article, "Weather Seminars: New Answer To Old Problem," told of the U. S. Weather Bureau's attempt to upgrade general aviation pilots' weather education through one-day weather seminars. The article went on to point out that the Bureau was preparing for publication "Guide For A Weather Seminar," a comprehensive outline designed for use with visual aids and texts in the presentation of these seminars. "The Weather And Human Factors" is the first in a series of four articles based on the Guide. In preparing this series for The PILOT, author-pilot Barbara Witchell Tully,*

*a former free lancer for and now a staff member of The PILOT, worked closely with the two men most responsible for the Guide—N. A. Lieurance, Director of Aviation Weather Services, and Stanley J. Lacy, who is in the Bureau's Forecasts and Synoptic Reports Division. This series is not designed as a substitute for the weather seminars; rather it is hoped that by giving pilots a better understanding of how weather affects their flying, these articles will stimulate interest in the presentation of such seminars throughout the country. In the March issue of The PILOT, the second article will discuss fronts, clouds and visibility.*

**T**he need for pilots to acquire a better understanding of weather is emphasized by the increasing number of general aviation accidents with weather as a contributing factor.

To help fill this need, the United States Department of Commerce Weather Bureau in Washington, D. C., proposes to publish a "Guide For Aviation Weather Seminars" which will serve as a pattern for a one-day refresher course in weather subjects. "This Guide," says N. A. Lieurance, Director, of Aviation Weather Services, "is designed to assist any aviation minded group in presenting such a training session. It is planned to have the seminar guide complete in itself, with all basic visual aids and reference materials included so that a group wishing to sponsor a seminar would need only a minimum amount of time to prepare and present it."

With the realization that a refresher course in weather is difficult for pilots to find, the Weather Bureau's Guide, upon which this article and those to fol-

low is based, hopes to stimulate interest throughout the country for the presentation of such seminars.

Major points of interest will give the highlights of weather problems and flight to the student pilot, the novice pilot, the pilot with some experience who has not had the advantage of weather training recently, and the pilot who has not yet encountered weather problems in flight.

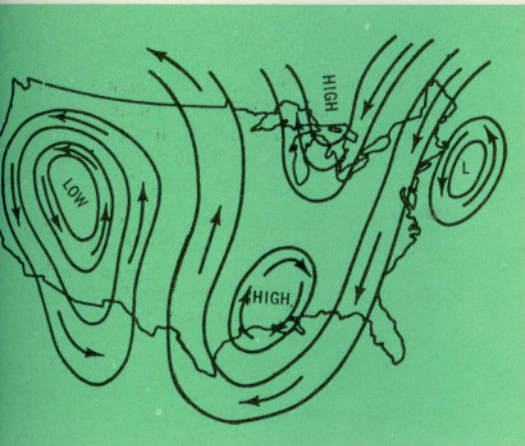
All too often, pilots are either unaware of, or unwilling to admit to, limited capabilities in themselves or in their equipment when it comes to "flying weather." It is also a fact, supported by the accident record, that many pilots have come to the end of the line because they didn't recognize weather symptoms early enough or didn't even know what to look for. A good many pilots today, due to the rapid growth of business-type flying without a corresponding growth in weather services, start out on a flight with no weather briefing at all. For that reason, being able to recognize



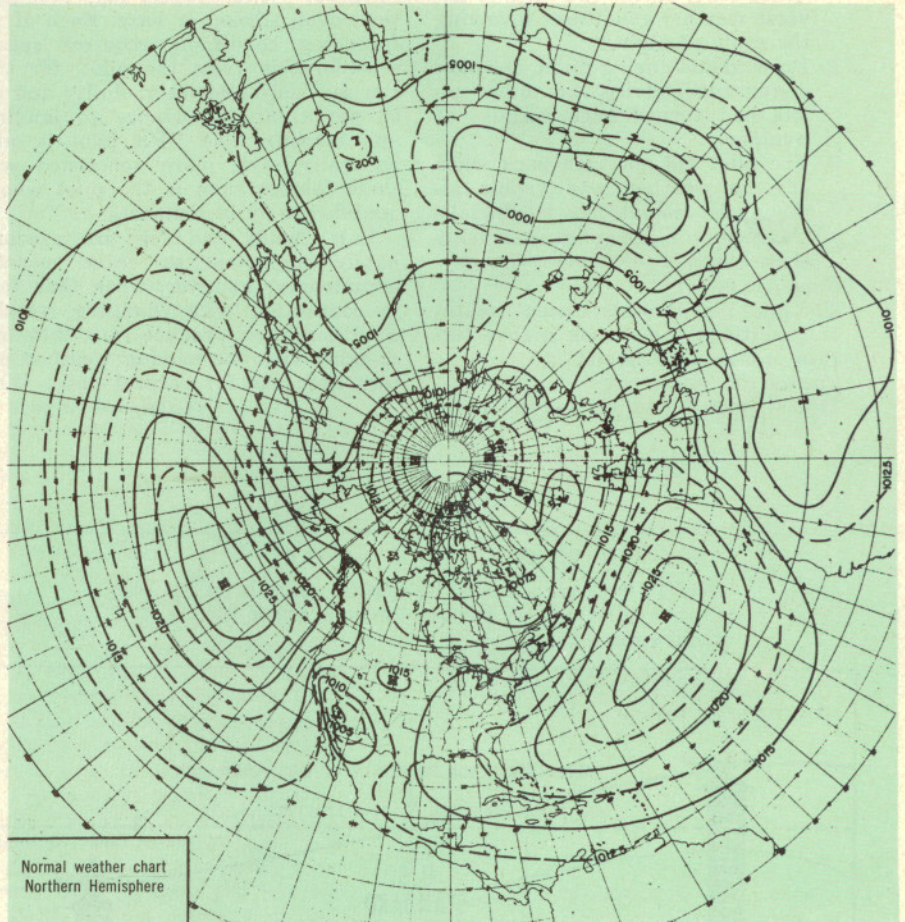
# Human Factors

As an outline for one-day weather refresher courses, the Weather Bureau plans to publish

a 'Guide For Aviation Weather Seminars.' This is the first in a series of four articles based on the outline for the Guide



◀ FIGURE 2. Wind flows the opposite direction around high and low pressure areas



▲ FIGURE 1. High and low pressure areas on a weather map are indicated by lines called isobars drawn through points that have the same barometric pressure

weather signs is as important as knowing how to take off and land a plane.

On the other hand, many pilots who have some knowledge of weather symptoms don't know where to go to obtain weather information or even how much is available to them. This lack of information and all related factors that concern the pilot's knowledge of the weather are contributing factors to the one-third or more accidents caused by weather every year.

At the request of the industry-Government committee for the study of general aviation weather accidents, members of the Civil Aeronautics Board were asked to study a group of weather-associated accidents. The CAB members picked 20 cases at random. They covered a cross section of the geographical United States. Some of their findings, which are cited here, speak for themselves:

*Case No. 1.*

The pilot lost control of the aircraft  
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## The Weather And Human Factors

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while flying at a high-density altitude in the vicinity of thunderstorms, over rugged terrain where moderate turbulence could be expected.

### Causal Factors

1. The pilot had obtained no weather briefing.
2. Lack of appreciation or understanding by the pilot of the possibility of turbulence in the vicinity of thunderstorms over rugged terrain.
3. The flight was in conjunction with an organized mission, thus, facts suggest poor preflight briefing and planning at the supervisory level.

### Case No. 4.

The aircraft crashed out of control in adverse weather conditions while the pilot was maneuvering in the vicinity of an emergency airfield. The accident occurred in fading light, low ceiling and visibility.

### Causal Factors

1. The pilot disregarded a full and complete preflight weather briefing which reflected the existence of adverse weather conditions involving the route of flight.
2. Prior to and during flight, the pilot disregarded advice that other pilots had turned back because of weather.
3. The pilot did not turn back when adverse weather was visible although he indicated he would take this action. The pilot had only three hours of instrument flying.

### Case No. 8.

The pilot flew into instrument weather conditions and struck higher terrain obscured by clouds.

### Causal Factors

1. The pilot failed to use the route

which weather briefing indicated was VFR and took the route of flight where clouds were reported to obscure high terrain.

2. Overconfidence of the pilot relative to inherent weather dangers. The pilot had no instrument rating and only five hours of simulated instrument training.

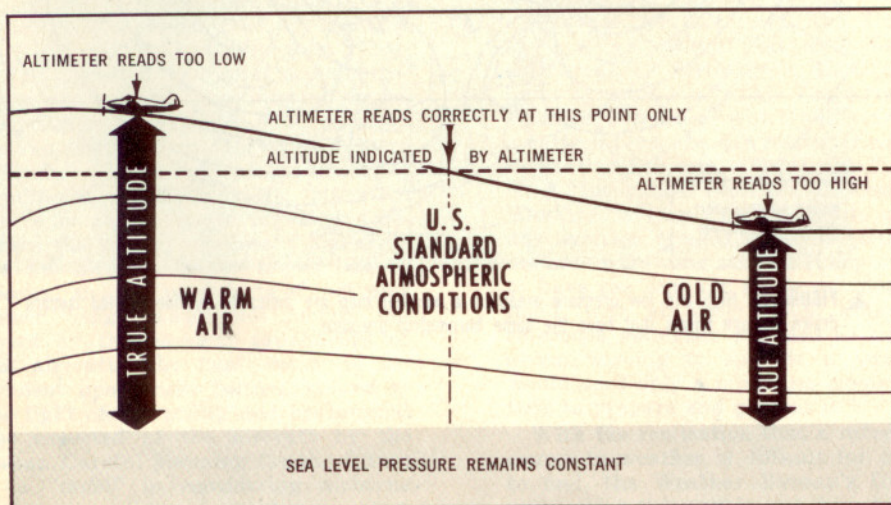
Last spring, an aircraft departed Lantana, Fla., and crashed 14 miles east of Ocala, Fla. The pilot had been thoroughly briefed on weather conditions by the Weather Bureau and at three FAA stations. He was warned of severe thunderstorm conditions. The pilot asked if he could circumvent the area. He was told "no." He then asked if he could top the weather and was reminded that the general tops were 22,000 feet to 25,000 feet. The pilot's last question was could he get under the weather. He was given the Advisory for Light Aircraft in which the warning was given of ceilings below 800 feet and visibilities below two miles. He took off anyway. The day—April Fool's Day.

Any condition which tends to reduce the amount of horizon visible to less than that of the natural horizon is "weather"—low clouds, fog, precipitation, dust, smoke, or haze. Each of the foregoing conditions requires special consideration from the pilot, for they can seriously restrict visibility and are of particular importance to landings and takeoffs. The VFR pilot is quite naturally even more concerned with these factors than is the pilot who is qualified to fly instruments.

Low clouds and fog are predominately nighttime or early morning occurrences; however, when they form in connection with changing weather conditions that produce rain, they may co-exist with the moving weather pattern and last for several days. When

(Continued on page 70)

**FIGURE 3.** If not set accurately, the altimeter reading is too high when the air is colder, and too low when the air is warmer than the U. S. standard atmosphere







Stanley J. Lacy, who joined the Washington, D. C., offices of the United States Weather Bureau in 1949, is one of the originators of the Bureau's Guide to Aviation Weather Seminars

N. A. Lieurance, with whom the idea of the "Guide for Aviation Weather Seminars" originated, is Director of the Weather Bureau's Aviation Weather Services. He was awarded the Flight Safety Foundation's Annual Safety Award in January 1962, "for outstanding contribution to aviation safety"

## Weather And Human Factors

(Continued from page 32)

flying in an area of continuous rain, fog and low clouds almost always may be expected.

Haze occurs when the lower layers of the atmosphere are calm, and small particles of dust or other impurities other than smoke become mixed with the atmosphere. Smoke is most often found in the areas that surround cities that have a large amount of manufacturing plants or industrial activity. When haze and smoke occur together with fog and low clouds this combination is known as "smog." This combination also results in a very considerable reduction of surface visibility to a greater or lesser extent at different altitudes.

Tornadoes, typhoons, hurricanes and all violent atmospheric occurrences are included under the heading of "weather," but most of these are obvious and usually can be easily avoided. The most dangerous characteristic of these weather phenomena is severe turbulence that has caused many a pilot to lose control of his plane and meet sudden death. Unnatural stress is also placed on an aircraft in conditions of this nature and cause structural failure.

High and low pressure areas are additional fundamental weather conditions that the pilot should know about. Good or bad weather is often associated with pressure areas. If a pilot ignores pressure areas when setting his altimeter he will be flying higher or lower than his altimeter indicates.

Stormy weather, cloudiness, and precipitation are characteristics of low pressure areas. A low pressure area is indicated on a weather map by lines called isobars—that is, lines drawn through points that have the same barometric pressure. (See figure 1.) The

center pressure is less than anywhere around it and the surface winds circulate around this center in a counter-clockwise direction. If a pilot flies into an area of low pressure without changing his altimeter setting, he will then be lower than indicated.

High pressure areas are characterized by fair weather, little or no cloudiness or precipitation. Cold highs often will have turbulence and gusty surface winds. A high pressure area is outlined by isobars on the weather map, in which the center pressure is greater than anywhere around it and the surface winds circulate around this center in a clockwise direction—the opposite of the low pressure areas. (See figure 2.) If a pilot flies into an area of high pressure without changing his altimeter setting, he will be higher than indicated. (See figure 3.)

Local observations are made and reported in terms that have meaning for pilots. As nearly as possible, many of the terms and measurements used to report weather elements have been arrived at through discussion with pilot groups. For instance, cloud heights and ceilings are reported in hundreds of feet; horizontal visibility, with regard to recognizable objects, is reported in miles and fractions; wind speeds, in knots. It must, however, always be kept in mind that conditions may often appear different to the pilot in the air from what they appear on the ground.

The old saying, "The spirit's willing, but the flesh is weak," is just as applicable to flying as it is to other situations in life. If a pilot can recognize his physical limitations then he can avoid exceeding his limits. If he can recognize the danger signs in mental attitudes, he can steer clear of trouble just as easily as he can avoid a tornado. There are red lines indicating safety limits on an airplane's instrument panel—like-

wise the individual should have his own red lines for physical and mental indicators.

There are several factors that are of primary importance to safe flying in relation to physical well-being. If a pilot, at any time, has a temporary impairment of any one of the following he should by all means remain on the ground.

**Sight**—A pilot's reference to the horizon enables him to maintain straight and level flight. The loss of the horizon through lack of visual reference can disturb the sense of balance and equilibrium. Nausea can result and eventual loss of control of the airplane. A case in point is the Midwest executive who received his private pilot's license with the restriction that he wear his glasses while flying at all times. One day he was in a hurry to make a business appointment in a nearby city. He rushed to the airport, discovered he had forgotten his glasses, but figured he could get by "this time." His wife later told accident investigators that her husband "was not supposed to be without his glasses at any time." This was given as the probable cause of the accident because the weather was good and the man was recognized by his colleagues as being a good pilot.

**Hearing**—The human body normally accustoms itself to environmental noises. An extraneous noise when a pilot is trying to detect normal sounds (such as radio transmissions with static) or a totally strange noise when imposed on an already high noise level can be highly irritating to the nervous system, thus causing over anxiousness, alarm and distraction from normal in-flight procedures. If a person's normal hearing is slightly impaired for any reason it will follow that he will become "edgy" and likely to panic in a critical situation where acute hearing is necessary.

**Feeling**—Sense of balance and equilibrium, if not in good order, can quickly cause a pilot a case of vertigo and nausea if he gets into any turbulence or loses his visual reference.

The basic sensory functions, if not in tip-top shape, can cause a pilot unlimited grief. Right in line with these functions come the bodily functions—breathing and digestion.

Our bodies need the normal requirement of oxygen. This is not supplied when flights are prolonged above 10,000 feet without proper oxygen equipment. The first signs of hypoxia (insufficient oxygen) are drowsiness and a complete sense of well-being and relaxation. Falling asleep at the controls will never mean the completion of a safe flight.

Proper digestive processes and sobriety are also factors that contribute to the good health and safe flying of a pilot—over indulgence in food or drink is not good flight insurance.

A pilot should always be in good health and free of mental stresses in order that he can be alert, and exercise safe reasoning and clear thinking. He has this moral obligation to himself as well as to the other pilots who fly the airways with him. END